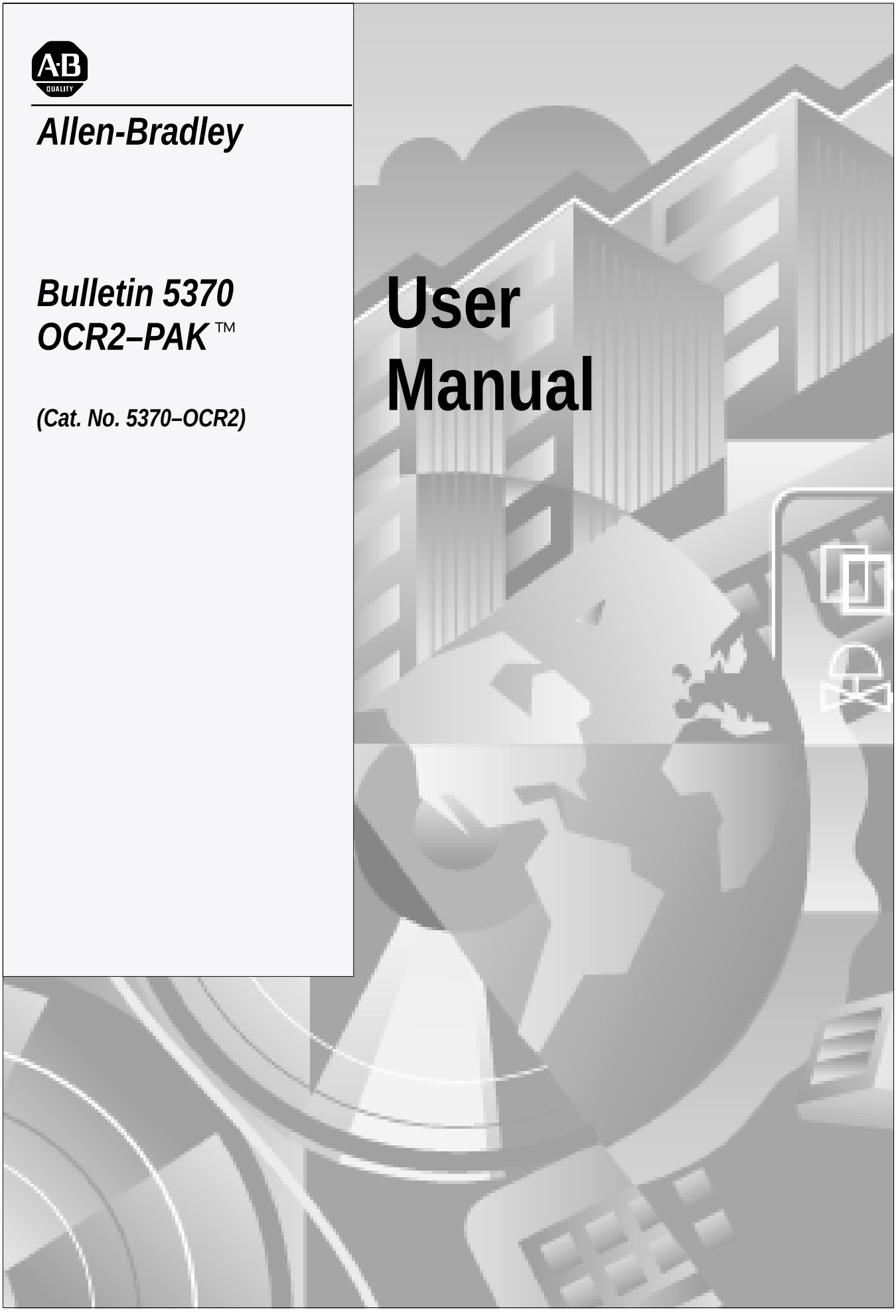
Allen-Bradley

Bulletin 5370 OCR2–PAK™

(Cat. No. 5370–OCR2)

User Manual



Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we use notes to make you aware of safety considerations:

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

Important: Identifies information that is critical for successful application and understanding of the product.

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Chapter 1

Using this Manual

Chapter Objectives

Read this chapter to familiarize yourself with the rest of the manual. You will learn about:

- Contents of this manual
- OCR2-PAK definition
- Intended audience
- Conventions used
- Terminology
- Related publications.

Overview of Manual

The following table describes the contents of each chapter in this manual.

Manual Contents

Chapter	Title	Purpose
1	Overview of this Manual	Introduces you to the OCR2-PAK software package and provides you with a list of related documents and conventions.
2	Introduction to OCR2-PAK	Describes key features, specifications, restrictions, and other application considerations.
3	OCR2-PAK Installation	Provides instructions for installing OCR2-PAK.
4	OCR Tool Configuration	Describes how to setup an OCR tool.
5	Creating Inspection Fonts	Describes how to train OCR2-PAK to recognize characters.
6	Using OCV	Describes how to configure and test match strings for OCV.
7	Inspections	Describes how to perform Test and On-Line inspections.
8	Communications and I/O	Describes how to access OCR results and perform configuration functions through a CVIM2 communications port.
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OCR2 PAK Definition

OCR2-PAK (Catalog No. 5370-OCR2) is an enhancement to the CVIM2 (Catalog No. 5370-CVIM2) inspection tools that provides Optical Character Recognition (OCR) and Optical Character Verification (OCV).

OCR2-PAK is installed in the CVIM2 using a memory card. With OCR2-PAK installed, **OCR** is listed as an additional selection in the CVIM2 **Tool Types** panel. All parameters for an OCR window are configured through popup menus using a light pen or mouse (trackball).

Intended Audience

No special knowledge is required to use OCR2-PAK. However, you must understand how to configure and operate the CVIM2. Refer to the user manuals (see related publications, next page).

Conventions

This manual uses the following conventions:

- "Mouse button" refers to the left mouse button.
- References to "Mouse" are synonymous with "Light Pen" in this manual.
- If a menu command, button or check box is grayed out or shaded that item is not available for use at that time.
- **Click** means to position the cursor in the specified area and press / release the mouse button without moving the mouse.
- **Choose** means to perform a menu command or check a check box.
- **Select** means to highlight a selection from a list or series.
- **Dragging** or **Drag** (Mouse) is performed by pointing to an object, pressing the mouse button and holding it down while moving the object.
- **Dragging** or **Drag** (Light Pen) is performed by positioning the light pen tip over an item on the screen and pressing the tip against the screen until a cross (+) symbol appears. Release the light pen tip from the screen, then drag the item across the screen. Press and release the tip against the screen when the item is at its final position.
- **Toolset** refers to a set of one or more tool types that are assembled to perform an inspection. The CVIM2 system can run one configuration (file) at one time, and that configuration file may contain up to six toolsets, each of which can contain one or more tools.
- **Tool** refers to any of the tool types, such as "gage," "window," and so on. In this context, the OCR tool is just one of the tool types that a toolset may contain.

Terminology

This manual contains some terms that you may not be familiar with. Use the glossary at the back of this manual for assistance.

Related Publications

The following table lists related publications. We recommend that you read the CVIM2 Reference Manual (Catalog No. 5370-801) before using the OCR2 package.

Related Publications

Publication / Catalog Number	Description
5370-801	CVIM2 Reference Manual
5370-804	CVIM2 Communications Manual

Chapter 2

Introduction to OCR2-PAK

Chapter Objectives

This chapter describes:

- OCR2-PAK
- Font training
- Verification
- Recognition
- Character requirements
- Ambiguous characters

OCR2-PAK Description

Overview

OCR2-PAK is an enhancement to the CVIM2 that provides Optical Character Recognition (OCR) and Optical Character Verification (OCV). After OCR2-PAK is installed, OCR is listed as an option in the Tool Types panel.

An OCR Tool can be used in two ways:

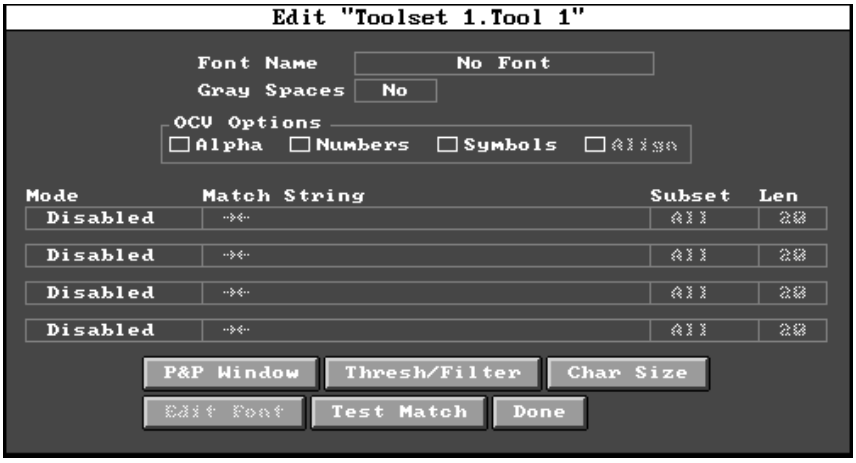
- OCR mode reads characters within the tool's processing window. It does not use a match string to verify what text is present.

- OCV mode reads characters within the tool's processing window, and compares the text read to a match string entered by the user.

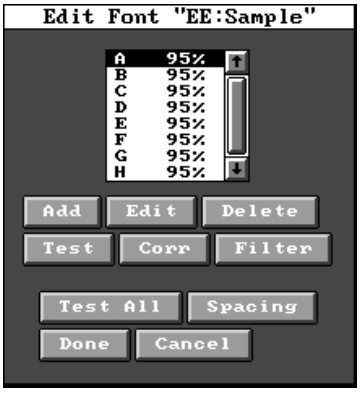
Both OCR and OCV have standard and strict operating modes. These modes determine how the OCR2 package handles printed characters that correlate with two or more different taught characters.

Tool Panels

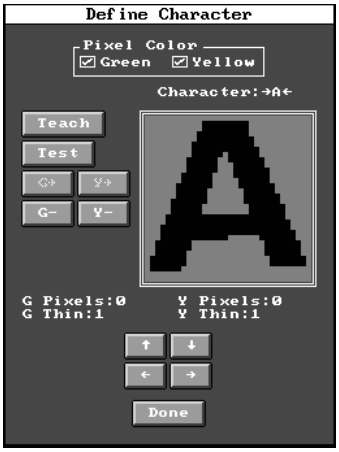
New tool panels are created when OCR2-PAK is installed. There are three basic panels for OCR2-PAK:



Use the **Edit OCR Tool** Panel to configure an OCR Tool.



Use the **Edit Font** panel to add, remove, and test characters from a font list.



Use the **Define Character** panel to teach and test a single character.

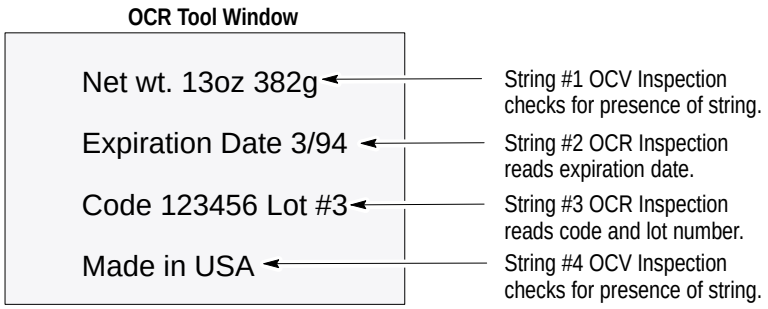
Font Training

Setup of the OCR Tool for inspections requires that you teach or train the CVIM2 to recognize your set of characters (font). This means that you can train the OCR2 package to recognize just about any character.

When you train the system, all of the taught letters, numbers and symbols are stored as a group called a font. Fonts can be copied, edited or deleted from a font listing.

Multiple Strings

An OCR Tool can inspect up to 4 strings of up to 20 characters each. Each string can have its own OCR or OCV operating parameters assigned.

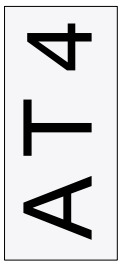

OCR Tool Window
Net wt. 13oz 382g
Expiration Date 3/94
Code 123456 Lot #3
Made in USA
String #1 OCV Inspection checks for presence of string.
String #2 OCR Inspection reads expiration date.
String #3 OCR Inspection reads code and lot number.
String #4 OCV Inspection checks for presence of string.

Character Requirements

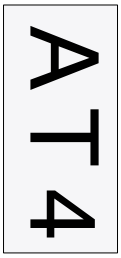
The following requirements must be met for character recognition.

Character Orientation and Direction

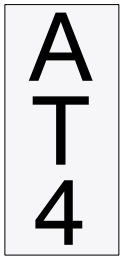
The OCR Tool inspects only horizontal strings. If your characters are rotated, you can use the Build Reference Tool as described in the CVIM2 Reference Manual to rotate the OCR Tool prior to inspection.



Vertical String
Bottom-to-Top Orientation
Tool must be Rotated -90°



Vertical String
Top-to-Bottom Orientation
Tool must be Rotated +90°



Non-Recognizable Orientation As Single String

Horizontal String

Note: The Non-recognizable example above could be inspected using 3 strings in one OCR Tool.

Character Height

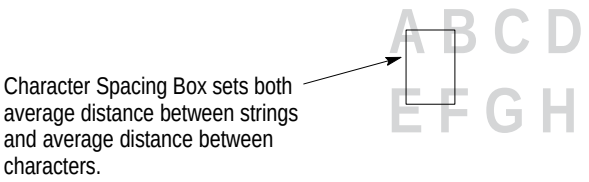
It is recommended that the height of the characters in the inspected image be at least 24 pixels. Although it is possible to read characters which are smaller, the reliability of the inspection may be reduced. For best reliability, the characters should be at least 32 pixels high. Characters may be as tall as desired.

The inspected characters must be approximately the same height from inspection to inspection, but the OCR Tool can be reconfigured to handle a change in character size. If text appears in more than one size on a single image, different OCR Tools, with different character sizes, must be used.

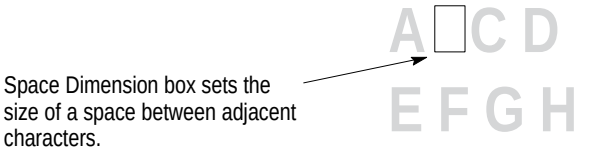
Thinning of the taught character may provide some tolerance to small changes in size. If all of the inspected characters are increased or decreased in size by the same amount, you can use the Rescale function to reconfigure the tool to the new character height. This eliminates the need to re-teach a font when the height of the inspected characters changes.

Character and String Spacing

When characters are taught, you use a **Character Spacing** box to set the distance between the centers of characters, both horizontally and vertically. No spacing between characters is required, however, characters should not overlap.



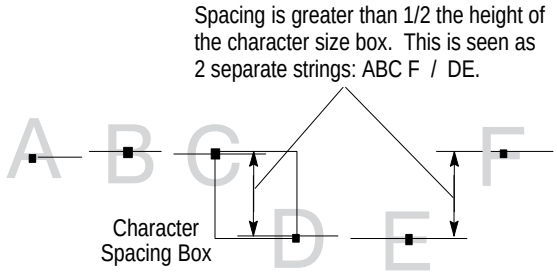
The size of spaces between characters is defined by the **Space Dimension** box. This is used to detect spaces between characters.



Character Alignment

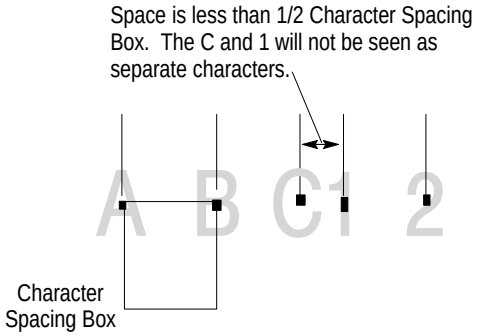
Vertical Alignment

Characters within a string are considered part of the same string if the vertical distance between adjacent correlation boxes is less than 1/2 the height of the Character Spacing Box. If the distance is greater than 1/2 the Character Spacing Box, the character is part of another string. For optimum reliability, all of the characters in the string should be aligned vertically so that at least 50% or more of the characters overlap.


Spacing is greater than 1/2 the height of the character size box. This is seen as 2 separate strings: ABC F / DE.
A B C F
Character Spacing Box
D E

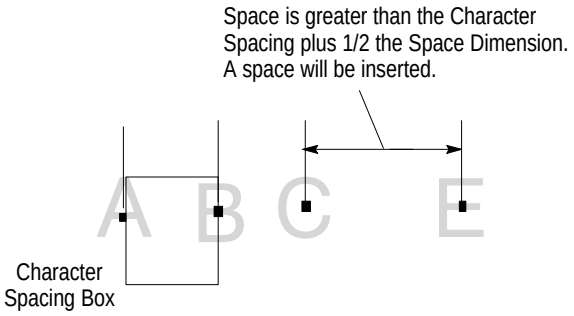
Character Separation

Characters are considered separate characters if the distance between the correlation boxes is equal to or greater than $^1/_2$ the width of the Character spacing box. If the distance between the correlation boxes of two characters is less than 1/2 the width of the character spacing box, the OCR Tool will treat the two characters as a single ”confusion character” and in most cases the tool will fail.

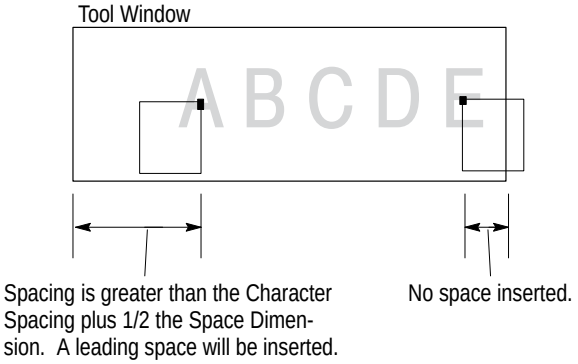

Space is less than 1/2 Character Spacing Box. The C and 1 will not be seen as separate characters.
A B C 1 2
Character Spacing Box

Spaces

When the distance between two printed characters is greater than the Character Spacing plus 1/2 the Space Dimension, a space is inserted into the read string.


Space is greater than the Character Spacing plus 1/2 the Space Dimension. A space will be inserted.
A B C E
Character Spacing Box

When the distance between the first or last characters and the left or right window boundary respectively is greater than the Character Spacing plus 1/2 the Space Dimension, a space is inserted before or after the read string.


Tool Window
A B C D E
Spacing is greater than the Character Spacing plus 1/2 the Space Dimen-sion. A leading space will be inserted.
No space inserted.

Gray Spaces

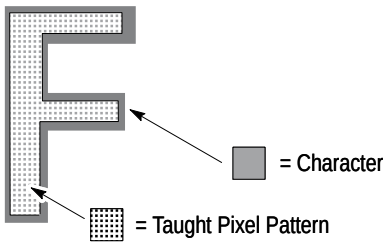
If the **Gray Space** option of the OCR Tool is enabled, each region of the image where a space is detected will be examined to determine the percentage of white pixels in the region. If the percentage exceeds a user–defined value, the space is called a *white space*. Otherwise, it is called a *gray space*, which indicates that it contains printing which is not recognizable as a character.

If the space between the tool window and the character string is large enough, the OCR Tool will also check for gray spaces in the regions immediately to the left and right of a string of printed characters. This enables the system to detect extra printing before or after the inspected string.

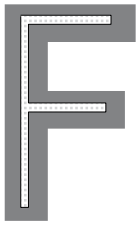
Character Rotation

If you expect the characters to rotate from inspection to inspection, you can use reference tools to correct for character movement and rotation within the field of view.

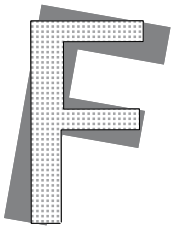
Some rotation may be acceptable without using a reference tool, if the characters were taught using the Thinning option.



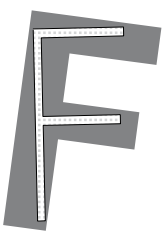
Original Taught Pattern



Thinned Pattern



A rotated character with
un-thinned pattern may not correlate.



A thinned pattern is
more tolerant to character rotation.

Character / Background Contrast

The contrast between the inspected characters and the surrounding background must be great enough so that, when configuring the OCR Tool, a threshold can be set to effectively distinguish the inspected characters from the background.

Good Contrast

Poor Contrast

Ambiguous Characters

There are several valid characters that can confuse OCR systems. Some numbers can be misread as letters and some letters can be read as numbers. Misreads are more likely to occur when the print quality is poor. The most ambiguous number and letter pairs are:

Number	Letter
0	O
1	I
2	Z
5	S
8	B

To prevent confusion between these characters, we recommend that you:

- If possible, don't use ambiguous characters in the same string.
- Use a different font. Some fonts have very little differences between characters. For example, in the Courier font the lowercase L (`l`) and the number (1) `1` are almost identical.
- Train the character templates carefully to reduce confusion between similar characters.

Character Quality

The quality or clarity of the inspected characters affects the success of the character recognition. Extra markings or breaks in characters can result in failed or incorrect recognition of a character. You must determine if the variation in characters is acceptable and adjust the taught font characters accordingly.

Other Character Restrictions

The following are some additional OCR Tool restrictions. However, these restrictions are unlikely to be encountered in most applications.

- There is a maximum of 4 ambiguous (confused) characters per character location in a string.
- Maximum number of spaces = 32. This includes leading, internal, and trailing spaces for all strings in the inspection window. Additional spaces are ignored.
- Maximum number of character strings in the tool window = 4.

Chapter 3

OCR2-PAK Installation

Chapter Objectives

This chapter describes:

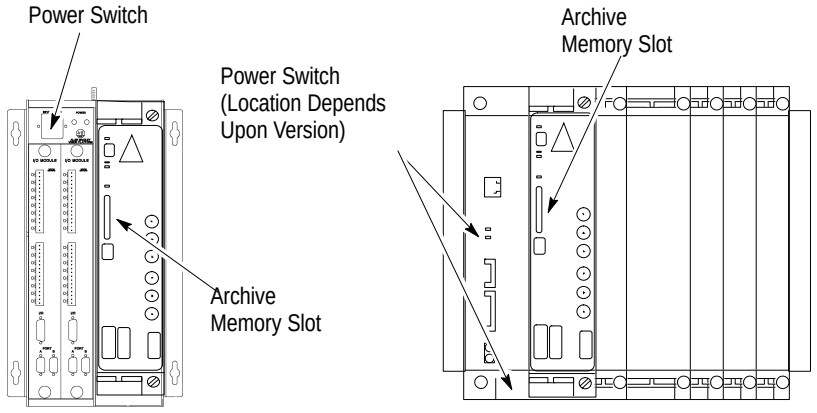
- Installing OCR2-PAK
- Accessing the OCR Tool

OCR2-PAK Installation

OCR2-PAK is provided on a memory card. You can only install OCR2 software in a CVIM2 module having Rev. B01 firmware or later.

To install OCR2-PAK:

1. Remove power from the module by turning off the power to the Pyramid Integrator or Vision Platform chassis.



CVIM2 in Vision Platform

CVIM2 in Pyramid Integrator Chassis

2. Insert the RAM card in the CVIM2 Archive Memory slot.
3. Apply power to the module by turning on the power switch.
4. The module will boot up and begin the package loading sequence.

5. While the package is being installed, you will see the following message:

```
Loading package MC:OCR2-B01
          into
       V1:OCR2-B01
```

6. When the Memory Active LED goes off and the screen displays the CVIM2 power up message, the downloading is complete. Verify that the power–up banner shows that OCR2–PAK has been installed.

On subsequent powerups, you are provided with the option to abort the running of all installed packages:

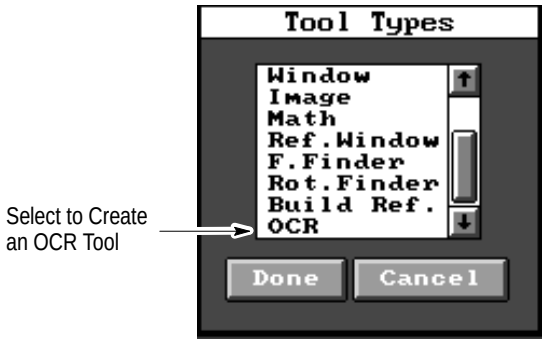
```
6 seconds to package run
[Abort Package Run]
```

If you abort the running of installed packages, the module will function as if the packages were not installed.

Note: You only need to install the OCR2-PAK once. After installation, OCR2-PAK remains installed for all subsequent powerups.

Accessing OCR2-PAK

After OCR2-PAK is installed, OCR is listed as an option on the **Tool Types** panel as shown below.



Chapter 4

OCR Tool Configuration

Chapter Objectives

This chapter describes how to:

- Create an OCR Tool
- Configure an OCR Tool

Procedure

The steps for creating an OCR Tool are listed below. You must perform the steps in the same sequence. If you are using Optical Character Verification (OCV), refer also to Chapter 6.

1) Add an OCR Tool in the toolset.
2) Edit the OCR Tool configuration.
3) Enter a Font Name.
4) Position Tool Window.
5) Set Threshold/Filter.
6) Set Character Size.

Refer to this Chapter

7) Enter and Teach characters.
8) Test taught characters.

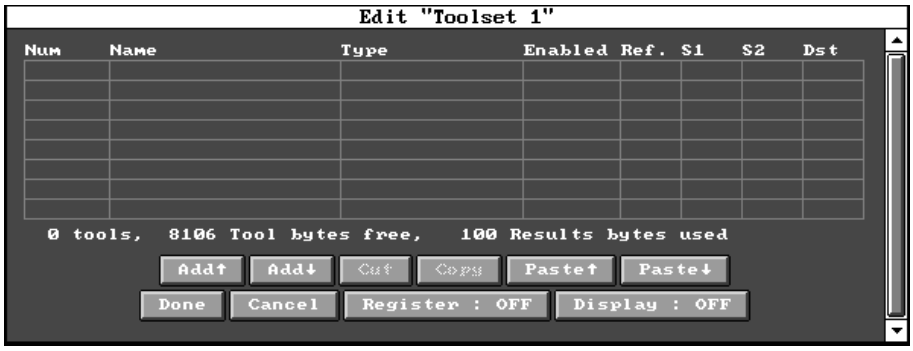
Refer to Chapter 5

9) Select string modes.
10) Enter match strings for OCV mode.
11) Select OCV options if required.

Refer to Chapter 6

Adding an OCR Tool

To create an OCR Tool, choose **Tools** from the menu on the **Toolset** image display panel. The following panel appears allowing you to add a new OCR Tool or copy an existing one:



The following are brief descriptions of the **Toolset Edit** panel. Refer to the CVIM2 Reference Manual (Catalog No. 5370-801) for detailed information on editing a toolset.

Num

The sequence number of an inspection tool. it indicates the order in which the CVIM2 system processes the tool number. The currently selected tool is marked by an arrow.

Name

The inspection tool name. All tools are provided a default tool number such as **Tool 1**. Clicking on the current name displays the keyboard for entering a new name.

Type

The inspection tool type such as OCR. Clicking the tool type box for a tool displays the edit panel for that tool.

Enabled

Indicates whether the tool is enabled, Yes or No. Yes is the default.

Ref

Use this field to select a reference tool for the purpose of providing shift and/or rotation compensation for the selected inspection tool.

S1

use this field to select the primary image source for a tool from a camera (such as C1) or from an image buffer (such as P1).

S2

Secondary image column is not applicable since OCR2 works with only one image source.

Dst

Indicates the destination of the image. P1 is the default for an OCR Tool indicating that the destination is a processed image.

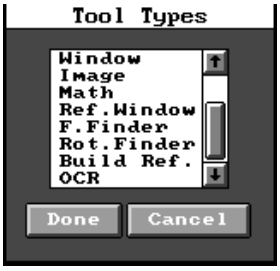
There are two ways to add tools to the Toolset:

- one way creates a new tool
- the other copies an existing tool which is modified

To create a new tool:

1. Choose either **Add ↑** or **Add ↓** button on the **Toolset** panel to add a tool above or below the currently selected [→] tool.

   The following panel appears with tool type selections.



2. From the list, select **OCR**. Click the **Done** button.

   An OCR Tool is added to the list in the **Toolset** panel.

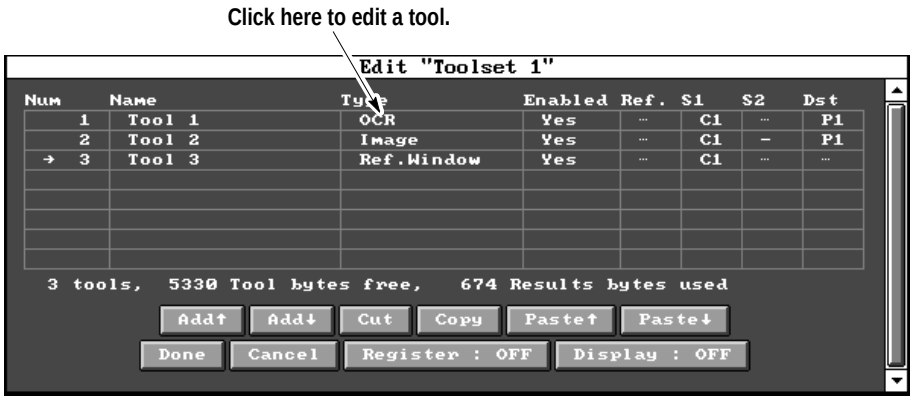
3. To edit tools, refer to next section Editing OCR Tools.

To copy an existing tool:

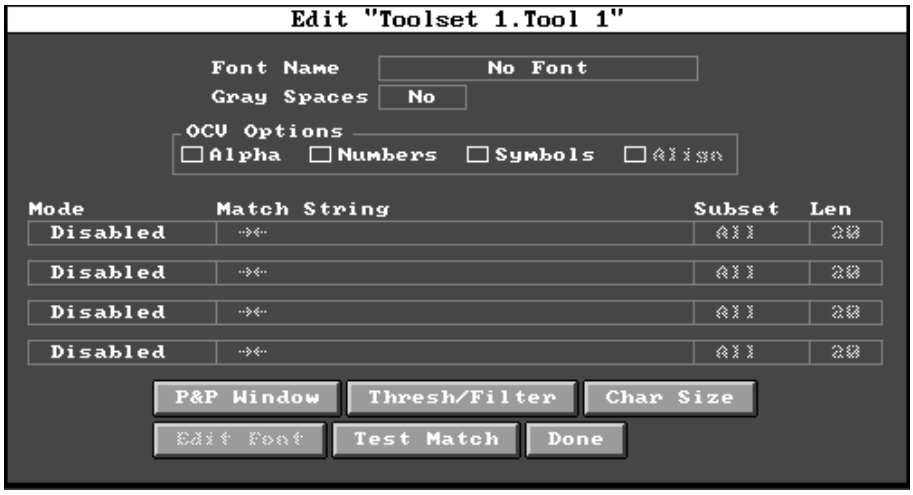
1. Select the OCR Tool to be copied by clicking the number using the mouse. The selected tool is indicated by an arrow[→].
2. Choose the **Copy** button and then the **Paste↑** or **Paste↓** button to place the copy OCR Tool before or after the the marked [→] tool.
3. The copied OCR Tool has the same attributes as the original tool.
4. To edit tools, refer to next section Editing an OCR Tool.

Editing an OCR Tool

To edit a new or existing OCR Tool, click OCR in the Type column of the tool listed in the **Toolset Edit** panel.

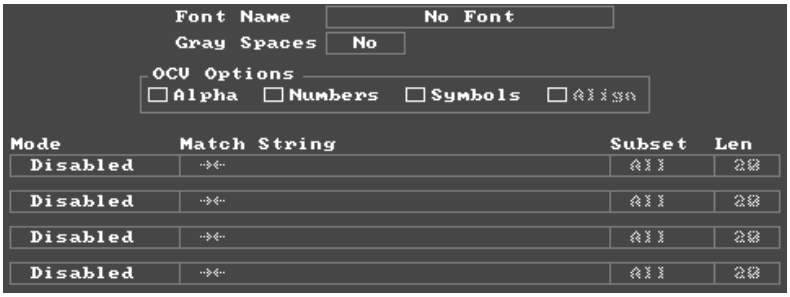

Click here to edit a tool.
Edit "Toolset 1"
Num Name Type Enabled Ref. S1 S2 Dst
1 Tool 1 OCR Yes C1 P1
2 Tool 2 Image Yes C1 P1
3 Tool 3 Ref.Window Yes C1
3 tools, 5330 Tool bytes free, 674 Results bytes used
Add↑ Add↓ Cut Copy Paste↑ Paste↓
Done Cancel Register : OFF Display : OFF

The following **OCR Tool Edit** panel is displayed showing the current configuration of the OCR Tool being edited.



OCR Tool Edit Panel

OCR Tool Edit Panel Components



The following describe the components of an **OCR Tool Edit** panel.

Font Name

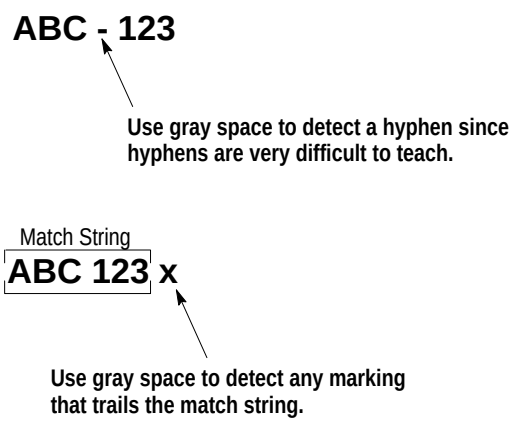
Indicates the currently active font. No Font appears in the box until a font is taught and added. Clicking in the Font Name box displays the **Font Selection** panel which allows you to select previously taught fonts or create a new font.

Gray Spaces

A gray space is a space (leading, trailing , or between characters) that contains a percentage of black pixels exceeding a preset limit. A white space contains a lower percentage (usually 0%) of black pixels. The black pixel limit is set using the **Define Spacing** function (see page 5–20).

If you select Yes for the **Gray Space** option, the OCR Tool will distinguish between gray and white space. If you select No, all spaces are treated as white space.

Below are examples of using the Gray Spaces option:


ABC - 123
Use gray space to detect a hyphen since hyphens are very difficult to teach.
Match String
ABC 123 x
Use gray space to detect any marking that trails the match string.

OCV Options

The **Alpha**, **Numeric** and **Symbols** options allow you to check for characters not contained in a match string, when using OCV mode. Otherwise the tool will not search for characters which are not present in the match string, and any other characters may be read as spaces.

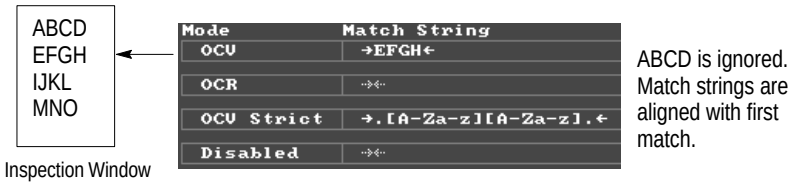
Enabling these options will generally increase the inspection time of the tool. With these options disabled, OCV is faster than OCR because it can verify a string by processing only the characters contained in the match string instead of processing all taught characters in the font. The **Gray Space** option is in most cases a faster method of detecting extra characters not present in the match string.

Clicking on a check box selects the item.

- ☑ **Alpha** specifies alphabetical characters (A → Z and a → z)
- ☑ **Numeric** specifies numeric characters (0 → 9)
- ☑ **Symbols** selects all characters other than alphabetical or numeric characters

Align

The **Align** option can be enabled only when the first string **Mode** is **OCV**. When Align is selected, the tool ignores all strings before the first string is matched. For example, you may want to match a string of characters that will not always appear on the first line in your window. The Align option allows you to ignore the characters on lines above the line that contains the first match string:



Note: Even with the **Align** option enabled, the number of lines of characters in the OCR Tool window is still limited to 4.

Mode

Specifies one of four operating modes: OCR, OCR Strict, OCV, or OCV Strict. A selection of Disabled indicates that the string is not inspected.

Refer to page 4–15 for a description of the operating modes.

Match String

In OCV mode, the recognized characters are compared to **Match Strings**, and the tool will fail if the strings do not match. If you select the match string box with OCV mode selected, a keyboard will be displayed, allowing you to enter a match string.

Metacharacters can be entered with the keyboard or by selecting the metacharacter buttons at the top of the keyboard. The metacharacter buttons include:

[A-Za-f]	Any alpha
[0-9]	Any number
?	0 or 1 occurrences of the preceding character
*****	0 or more occurrences of the preceding character
+	1 or more occurrences of the preceding character
|	OR operation

Refer to Chapter 6 for a complete description of match strings and metacharacters.

Subset

Subset allows you to inspect a portion of a string starting from the left or right end. The following options are available:

- All
  In this mode, all characters recognized (up to a maximum of 20) are included in the read string.
- Left
  When **Left** is selected and more than **Len** characters are recognized in a single string, the read string will consist of the left-most **Len** characters recognized.
- Right
  When **Right** is selected and more than **Len** characters are recognized in a single string, the read string will consist of the right-most **Len** characters recognized.

  Note: The maximum number of characters per line = 40. Any characters over 40 per line are ignored.

Len

Applies to the Left and Right subset options. When a subset of a string is selected you must enter the length of the subset.

OCR Tool Edit Panel Buttons

The following are brief descriptions of the buttons on the **OCR Tool Edit** panel. Each of these functions is described in detail in the applicable section.

P&P Window

Initiates the Pick and Place function, which can move and size the OCR Tool's processing window.

Thresh/Filter

Displays the **Threshold / Filter** panel used to adjust the high/low threshold settings and the Morph 1 filter.

Char Size

Allows you to set the size of characters within the OCR window. The character size must be set after the threshold/filter is set and before characters are taught.

Edit Font

Displays the **Edit Font** panel that allows you to teach and test OCR characters.

Test Match

Allows you to enter a string to be tested against the current match strings. This is used to test the operation of match strings which contain metacharacters. Refer to Chapter 6.

Done

Exits to the **Edit Toolset** panel.

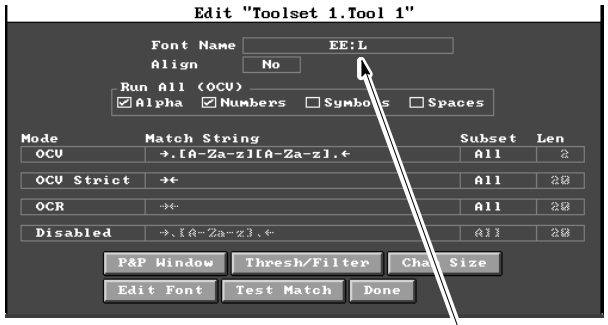
Enter a Font Name

A font is a collection of characters that have been taught and stored under a font name.

To add a new font:

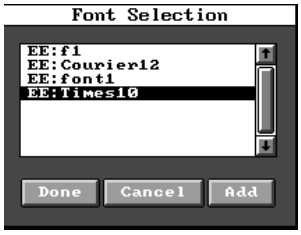
1. Click the in the **Font Name** box on the **OCR Tool Edit** panel

   The **Font Selection** panel is displayed allowing you to add a font name.



OCR Tool Edit Panel

Click in Font Name box



Font Selection Panel

2. Click the **Add** button.

   The keyboard is displayed allowing you to add a font name.

3. Enter a font name. A font name can be up to fifteen (15) characters, and can consist of any alphanumeric character (A-Z, a-z, 0-9). Spaces are not allowed. Also enter 3 character device type if not EE:. These 3 characters are in addition to the 15 for Font Name.

4. When completed select the **Done** button.

   The entered name appears in the Font Name box. Any taught characters will be saved under that Font Name. The font name appears as an option in the **Font Selection** panel.

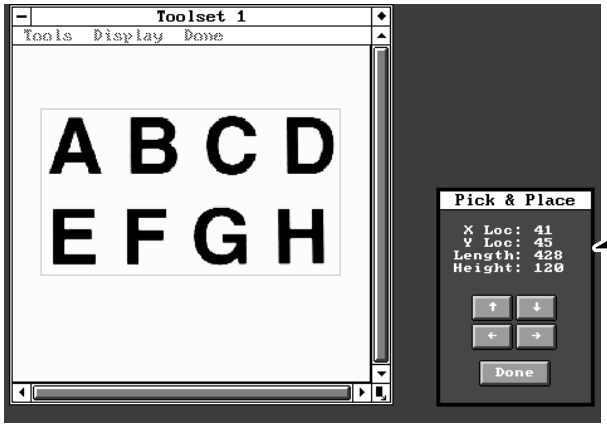
To add or edit characters in a font, refer to Chapter 5.

To delete a font:

Use the **Filer** function listed under the **File** menu. Refer to page 5–27

Position OCR Tool Window

This window defines the inspection area of a character string (strings). Move and adjust the window by clicking the **P & P Window** button on the **OCR Edit** panel and referring to the the following:



To move the Pick & Place Window

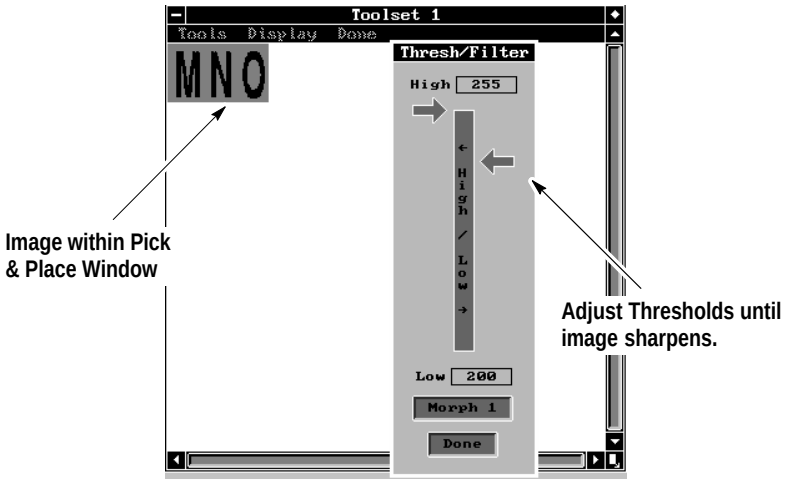
Click and hold down the mouse button in the middle of the window. Move the mouse while holding down the mouse button and drag the window over the characters to be read.

To size the Pick & Place Window

Click the mouse button on the corner of the window and drag the mouse until the window encloses all the characters to be read. You can also size the window using the arrow keys on the **Pick and Place** panel. Position the window around the strings to be read, allowing sufficient extra room to accommodate the expected movement of the strings within the field of view. You may want to provide space before and after the strings for leading and trailing spaces. Refer to space descriptions on page 2–6.

Set Threshold / Filter

The **Threshold / Filter** function allows you to adjust the thresholds and morphological filtering of the OCR Tool. Refer to the CVIM2 Reference manual (Catalog No. 5370-801) for additional threshold information.



If the characters to be read are *dark printing on a light-colored background*, set the *high* threshold to its maximum value of 255, and adjust the *low* threshold so that the characters are black and the background is white.

If the characters to be read are *light printing on a dark-colored background*, set the *low* threshold to its minimum value of 0, and adjust the *high* threshold so that the characters are displayed in black and the background is displayed in white.

The **Morph 1** button allows you to edit the Morph 1 filter settings, which can sometimes be used to improve the quality of the image. In most applications, the morphology filtering can be left in its default (Identity) state. Do not use the **Invert** morphology operation, this interferes with the tool operation.

Refer to the CVIM2 Reference manual (Catalog No. 5370-801) for information on setting morphology filters and on the Configuration Editor display settings.

Note: The appearance of the thresholded image which is displayed can be affected by the setting of the **Character Size**, and whether the **Scale** of the image display panel has been set to **1** or **To Fit** in the Configuration Editor.

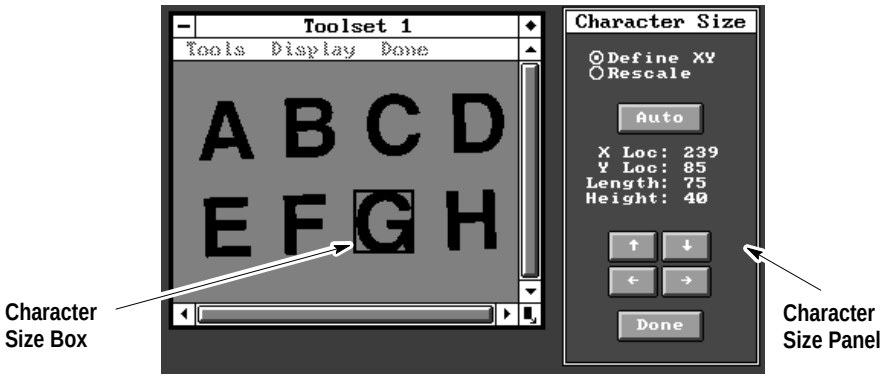
HINTS:

- Set the threshold before setting the OCR Tool's Character Size.
- Try to obtain the best contrast between the characters and the background without distorting the characters.
- Adjust the threshold so that you have a consistent "stroke width" of characters between the teaching and running OCR.
- A Light Probe can be used to reduce variation in image brightness. Refer to the **Camera** section of the CVIM2 Reference Manual for more information.

Set Character Size

The character size of an OCR Tool is used to determine the scale factor used during the processing of the OCR Tool. The inspected image will be scaled so that the characters become 32x32 pixels in size for image processing purposes. You must correctly set the Character Size before editing a new font.

Before setting the Character Size, adjust the Threshold so that the characters appear black and the background appears white. Use the **Character Size** panel to define the scale of the OCR Tool.



When you select the **Auto** button, a **Character Size** box is automatically placed around the character having the largest width. The Auto function works only on black characters on a white background. The height of the box will be the median height of the characters inside the window.

Note: The Auto function only processes the first 32 characters in the OCR Tool window to determine the maximum width and median height.

Rescale options affect both manual and automatic sizing:

- **Rescale**
  Select **Rescale** when **Character Size** is first set for a new font or when adjustments are made such as a line changeover, where the character size changes. If the **Rescale** option is shaded, you must add or select a font in the **OCR Tool Edit Panel** first.

  Rescale for a New Font
  When **Rescale** is selected, both the X and Y scale factors are set and the aspect ratio of X to Y (width to height) is stored with the font. The largest character of the font should be present in the inspection window.

  Rescale for an Existing Font
  When **Rescale** is selected, the **Character Size** is set based upon the height measurement only. The aspect ratio of X to Y (width to height) remains unchanged for the font. The widest character does not have to be in the OCR inspection window. This enables you to teach a font off-line and then reconfigure the tool's **Character Size** to match that of the inspected characters.

- **Define XY**
  Select **Define XY** when the camera aspect ratio (horizontal / vertical resolution) is changed for an existing font. When **Define XY** is selected, both the X and Y scale factors are set. The largest character in the font should be present in the OCR inspection window. Select **Rescale** after setting the **Character Size** with the **Define XY** option. This will store the aspect ratio with the font and set **Rescale** as the default **Character Size** option.

To set the character size:

1. Make sure that the largest character in the font is displayed within the pick and place window.
2. Choose either **Rescale** or **Define XY** (see previous page)
3. Click the **Auto** button.

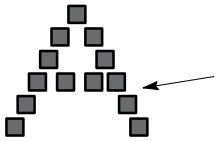
   Note: Auto **Character Size** works with character sizes in the range of 11 to 127 pixels. If the message "No Suitable Characters Found For Auto Char Size" is displayed, make sure that the characters in the source image are within the height range of 11 to 127 pixels.

   If the **Character Size** box is placed around the widest character, select **Done**.

   If the **Character Size** box is not satisfactory (it could happen when characters are touching each other or too many characters are inside the OCR window), you can manually adjust the **Character Size** box around the widest character in the font. Drag the character size box or use the arrow keys on the **Character Size** panel to move the box manually.

Important: Manually adjusting the **Character Size** box is not recommended. If possible, always use the **Auto** button.

In some cases, it may be necessary to adjust the character size manually. One example is when using dot-matrix characters, where the characters are composed of many separate dots which do not touch. In this case, you must manually place the character size box around the largest character.



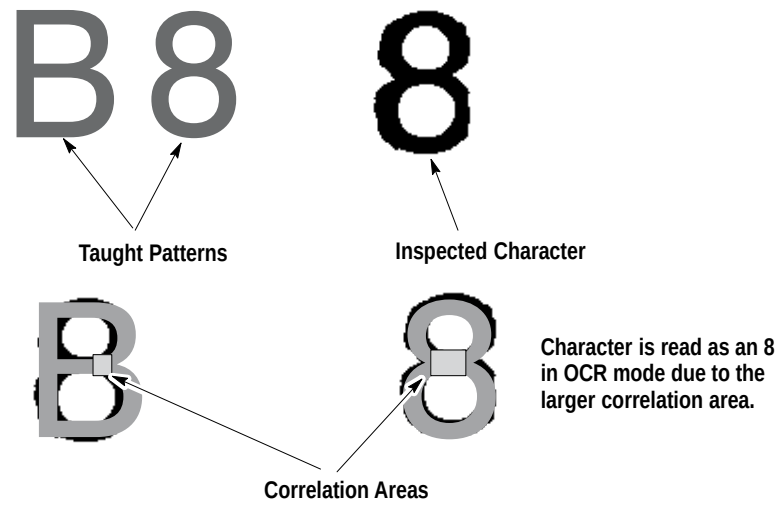
HINTS:

- You should note that in some fonts there are differences in the heights of letters and numbers. In addition, some lowercase letters may be taller than some uppercase letters. Use the largest character from the tallest class of characters to set the character height. Set the width using the widest character (usually M or W).
- Let the system select the **Character Size** automatically when first teaching the font for optimum results.
- The **Character Size** box should be tightly bound around the character that has the largest width of the characters in a font for optimum results.
- The **Threshold** must be properly adjusted before using **Character Size**.

Select Operating Mode

Each string of the OCR Tool operates in one of four modes. Use the following to determine the operating mode you require:

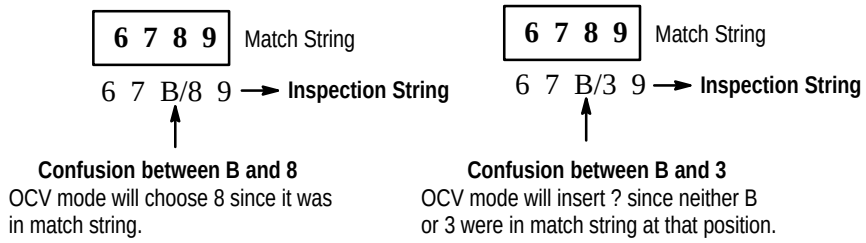
- **Disabled** indicates that the string is not used.
- **OCR Strict** is used to read text. The text is not tested against a match string. When a printed character correlates with two or more taught characters, a confusion character "**?**" is inserted into the result string. In **OCR Strict** mode, the string will pass if one or more characters are recognized and will fail if no characters are recognized.
- **OCR** is used to read text. The text is not tested against a match string. When a printed character correlates with two or more taught characters, the character with the largest correlation area is inserted into the result string. If a printed character correlates with more than 4 taught characters, a confusion character "**?**" is inserted into the result string. In **OCR** mode, the string will pass if one or more characters are recognized and will fail if no characters are recognized.


Taught Patterns
Inspected Character
Character is read as an 8 in OCR mode due to the larger correlation area.
Correlation Areas

- **OCV Strict** compares an entered match string against inspected strings. When a printed character correlates with two or more taught characters, a confusion character "**?**" is inserted into the result string. The presence of a confusion character may not prevent a match, depending upon the use of metacharacters. Refer to page 6–3 for metacharacter descriptions. In **OCV Strict** mode, the inspected string will pass if it matches the user defined match string and will fail otherwise.

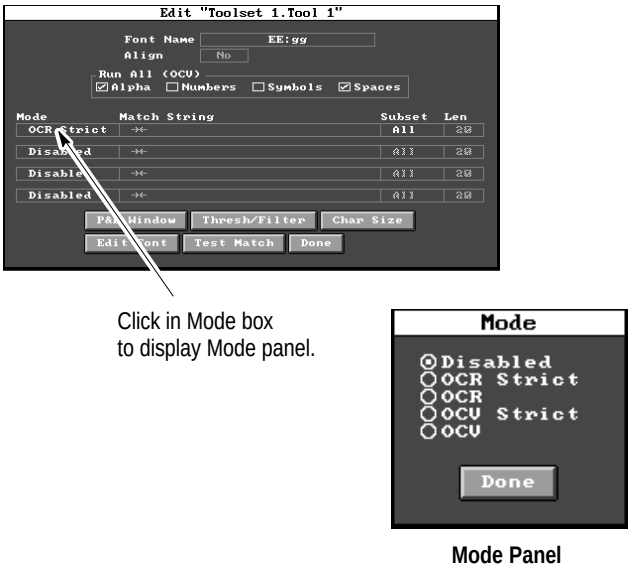
- **OCV** compares the entered match string against inspected strings. When a printed character correlates with two or more (but not more than 4) taught characters, the corresponding character from the match string will be inserted into the result string. In **OCV** mode, the inspected string will pass if it matches the user defined match string and will fail otherwise.

  If a printed character correlates with more than 4 taught characters, a confusion character "**?**" is inserted into the result string. The presence of a confusion character may not prevent a match, depending upon the use of metacharacters. Refer to page 6–3 for metacharacter descriptions.


6 7 8 9
Match String
6 7 B/8 9
Inspection String
Confusion between B and 8
OCV mode will choose 8 since it was in match string.
6 7 8 9
Match String
6 7 B/3 9
Inspection String
Confusion between B and 3
OCV mode will insert ? since neither B or 3 were in match string at that position.

To change the operating mode:

1. Click the cursor in the Mode box for the tool being edited. This brings up the **Mode** panel that allows you to choose the operating mode.



Mode Panel

2. Select the appropriate mode.
3. Click the **Done** button.

Chapter 5

Creating and Editing Fonts

Chapter Objectives

This chapter describes how to:

- Create and edit fonts
- Teach characters
- Test fonts

Important: Before teaching new characters, you should have set the following as described in Chapter 4.

- Entered a Font Name
- OCR Tool Window
- Threshold/Filter
- Character Size

OCR Fonts

Each OCR Tool uses one **OCR Font**, which is a file of character patterns used to perform OCR or OCV. Different OCR Tools can contain different fonts, or they can share a single font if they are to inspect the same type of text.

A font can contain any or all of the characters available on the pop-up keyboard, *except* the space character, underscores and the question mark. The size of the font file, and the amount of on-line memory used when the font is loaded, depends on the number of characters trained. When the CVIM2 system goes on-line, only those fonts currently used by OCR Tools are loaded into memory.

Font files can be stored on any of the CVIM2 storage devices. Normally, a font should be stored on the **EE:** device when it is first created. Once the font is fully trained, it can be moved to another storage device such as **V2:** which has a larger capacity. If a font file is moved to a different device, the **Font Name** must be changed in all OCR Tools that use the font, to reflect the new device name.

Introduction to Teaching Characters

Each character in a font is a 32x32 pattern of pixels, each of which can have one of three states:

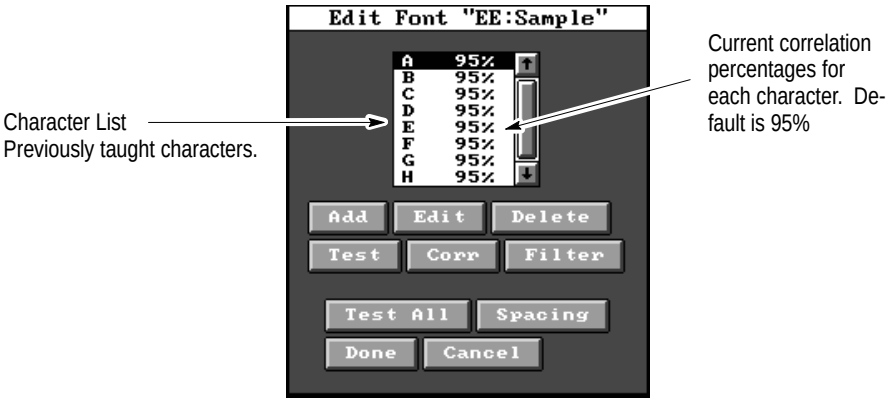
- **Black** - The corresponding part of the printed character is expected to be black.
- **White** - The corresponding part of the printed character is expected to be white.
- **Don't care** - The corresponding part of the printed character can be either black or white.

The **Font Editor** allows you to add character patterns to a font. After obtaining an image of the characters to be taught, a character pattern is taught by placing a box around the character, and using an automatic **Teach** function. The character pattern can then be further refined by manually adding or removing pixels, to maximize the distinction between different characters that are similar in appearance.

OCR Panels

Edit Font Panel

Access the **Edit Font** panel by selecting the **Edit Font** button on the **OCR Tool Edit** panel.



The scrolling list at the top of the panel shows the characters that are currently in the font. Click on an existing character in the list to select it as the current character. If this is a new font, the scrolling list will not contain any characters.

The following are descriptions of the buttons on the **Edit Font** panel.

Add

Adds a new character to the font. Clicking this button displays a keyboard for entering the character being taught.

Edit

Displays the **Define Character** panel for teaching, testing, and editing the currently selected character.

Delete

Deletes the currently selected character.

Test

Test the currently selected character against printed characters within the OCR Tool window. The location and correlation percentage of each character that correlates is displayed.

Corr

Displays the **Correlation** panel, used to adjust the percentage of correlation required between a printed character and a taught pattern in order for the character to be recognized.

Filter

Displays the **Morph 2** filter. This filter is applied after the **Morph 1** filter defined by the OCR Tool, and can sometimes be used to further refine the image of a particular character. In most applications this filter should be left at its default (Identity) setting.

Refer to the CVIM2 Reference Manual (Catalog No. 5370-801) for information on setting morphology filters.

Test All

Tests all taught characters (within the current font) against printed characters within the OCR Tool window. The location and correlation percentage of each character that correlates is displayed.

Spacing

Displays the **Define Spacing** panel used to define the spacing between characters.

Cancel

Exits to the the **OCR Tool Edit** panel without saving any changes.

Done

Saves changes to the font file and exits to the **OCR Tool Edit** panel.

If the memory device has insufficient space to save the font file or if some other type of problem prevents the font file from being saved, a warning will be displayed:

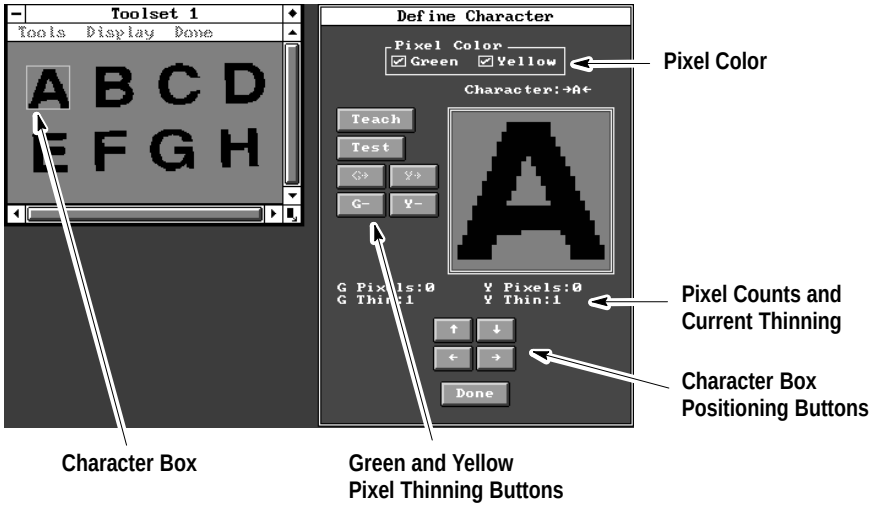
First press the **OK** button in the warning panel. The **Save As** panel will be displayed:

At this point you have the following options:

- Select a different file and press **Done** to save.
- Press **Other** to enter a new device and file name. You may need to select a device that has more available memory.
- Press **Cancel** to return to editing the font and possibly delete characters to reduce the size of the file.

Define Character Panel

Access the **Define Character** panel by selecting the **Edit** button on the **Edit Font** panel:



When the Define Character panel is selected, the Character Box is displayed in red, over the image display. Position this box over the printed character that is to be used in teaching the current character pattern. The box size can be reduced to exclude characters or noise around the character being taught.

Placing pixels within the character pattern

The **Define Character** panel shows an enlarged view of the portion of the image contained within the **Character Box**. Pixels in the character pattern are shown in yellow and green, where yellow indicates a pixel that is expected to be white, and green indicates a pixel that is expected to be black.

The Teach function automatically places green and/or yellow pixels within the character pattern. You can manually place or remove pixels by clicking the mouse within the displayed character pattern, at the location where the pixel is desired. The **Pixel Color** options (see below) determine what color pixel will be placed.

The following are descriptions of the buttons on the **Define Character** panel.

Teach

Teaches the character pattern based on the image of the printed character within the character box. Green and/or yellow pixels will be placed in the character pattern, based on the setting of the **Pixel Colors** (see below).

The green and yellow pixels are placed by ”thinning” the image of the printed character within the character box. The **G+, G-, Y+** and **Y-** options (see below) allow you to adjust the degree to which the image is thinned. Thinning increases the tolerance of the system to variations around the edges of the printed characters. See page 5–12 for a detailed description of the thinning process.

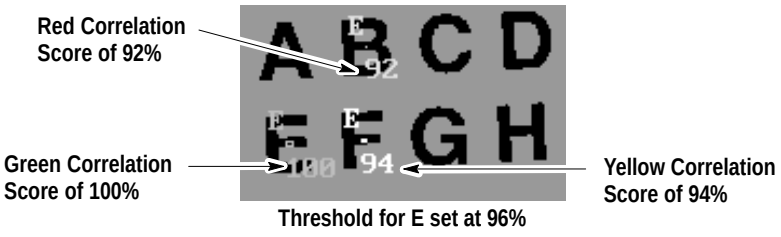
Test

Tests the taught character pattern against the printed character(s) within the OCR Tool window. The location and correlation percentage of each character that correlates is displayed.

Characters that correlate at or above the set correlation percentage are shown in green. These would be recognized by the OCR Tool.

Characters that correlate at or above 97.5% of the set correlation percentage are shown in yellow. These would not be recognized by the OCR Tool, however they are ”borderline” and minor changes to the image might cause them to be recognized.

Characters that correlate at or above 95% of the set correlation percentage are shown in red. These are also ”borderline” characters, but do not match as closely as those shown in yellow.



Pixel Color

Pixel color affects the auto teach function, and also manual placement of pixels within the character pattern.

		AUTO	MANUAL
☑ Green	☐ Yellow	Only places green pixels in character.	Place green anywhere.
☐ Green	☑ Yellow	Places only yellow pixels around character.	Place yellow anywhere.
☑ Green	☑ Yellow	Places both green and yellow pixels.	Place green in black. Place yellow in white.
☐ Green	☐ Yellow	Clears all pixels in auto teach mode.	Erase individual pixels.

G -

Reduces the number of green pixels by increasing the **G Thin** value and re-teaching the character. The **G Thin** value can be increased up to 5.

Y -

Reduces the number of yellow pixels by increasing the **Y Thin** value and re-teaching the character. The **Y Thin** value can be increased up to 5.

G +

Increases the number of green pixels by decreasing the **G Thin** value and re-teaching the character. The **G Thin** value can be decreased down to 1.

Y +

Increases the number of yellow pixels by decreasing the **Y Thin** value and re-teaching the character. The **Y Thin** value can be decreased down to 1.

Arrow Keys

Use the arrow keys to make fine adjustments to the placement of the character box.

Done

Exits to the **Edit Font** panel.

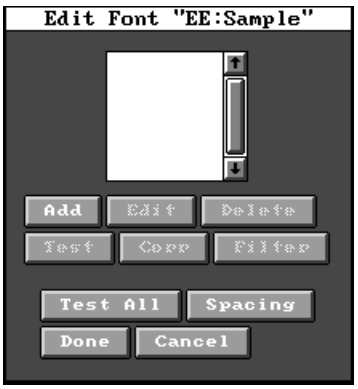
Adding Characters to Fonts

This section describes how to teach new characters in a font.

To Teach Characters:

1. Enter a font name, position the OCR Tool window, set the threshold, set the character size, and set the OCR mode. See Chapter 4.
2. Choose the **Edit Font** button from the **OCR Tool Edit** panel.

   The **Edit Font** panel appears allowing you to add a character to the current font.



3. Choose the **Add** button from the **Edit Font** panel.

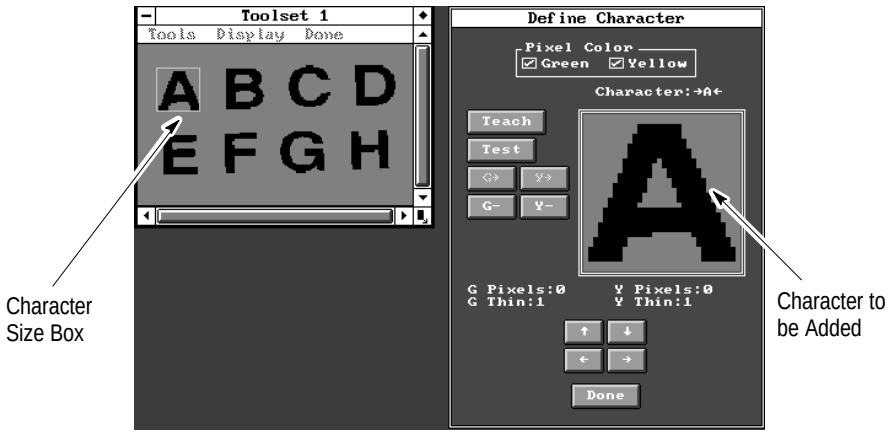
   The Keyboard panel is displayed allowing you to enter the character to be taught.

4. Enter the character and click the **Enter** button.

   The new character is added to the character list is highlighted.

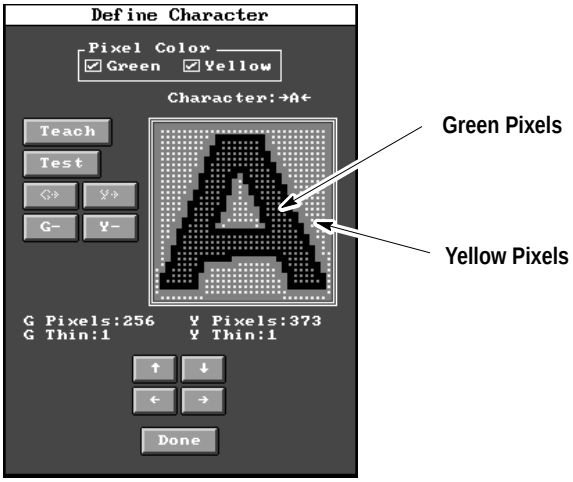
5. Teach the new character by clicking the **Edit** button on the **Edit Font** panel.

   The **Define Character** panel is displayed:



6. Make sure the **Character** box is placed over the character. Drag the box using the mouse and use the arrow keys if fine adjustment is required.

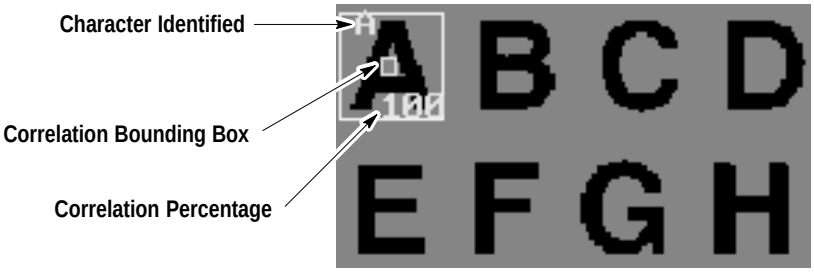
7. Click the **Teach** button. The character pattern will be taught and displayed in yellow and green.



8. At this point you may want to click the Y+, Y-, G+ and G- buttons to thin characters. Refer to page 5–12 for a description of thinning.

9. You can modify the taught pattern by changing or adding green and yellow pixels. Refer to Manually Editing Taught Characters on page 5–14.
10. Select the **Test** button.

    The correlation between the taught image and the characters within the OCR Tool window are displayed. Refer to page 5–6 for a description of correlation scores.



11. If the taught pattern correlates with printed characters other than the one being taught, modify the character pattern and/or the character's correlation score. Refer to page 5–25 for a description of how to eliminate these "confusion" characters.
12. Click the **Done** button to exit the **Define Character** panel.
13. Teach other characters by repeating steps 3-12.

Setting the Filter

This feature allows image enhancement to be applied to specific characters in the font. A separate set of filter parameters is stored with *each* character in the font. In most applications, the filtering should be left at its default (Identity) setting.

To define a filter:

1. Select the character whose filtering parameters you wish to modify.
2. Click the **Filter** button on the **Edit Font** panel.

   This displays the **Filter** panel.

3. Select Morph 2 to modify the filtering parameters for the character. Refer to the CVIM2 Reference manual (Catalog No. 5370-801) for information on setting morphology filters.

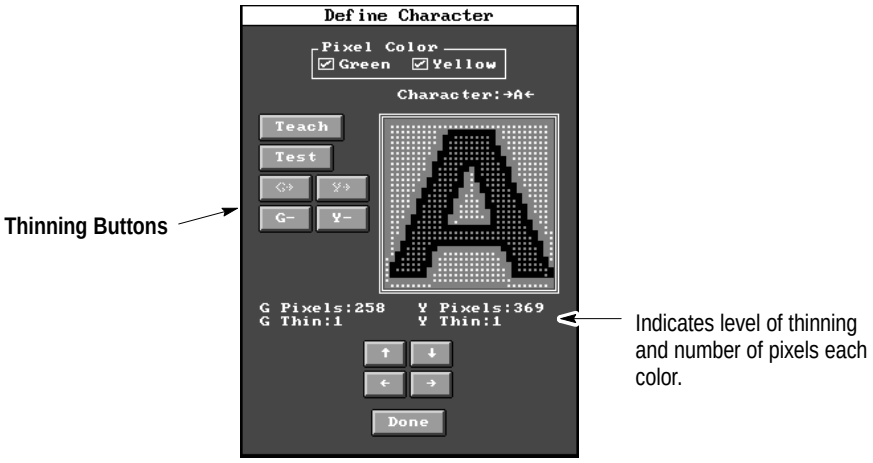
HINTS:

- Sometimes lighting conditions or part conditions cause some characters to be wider or narrower than the others. The **Filter** can widen or narrow the character so that it matches the norm of the other characters.

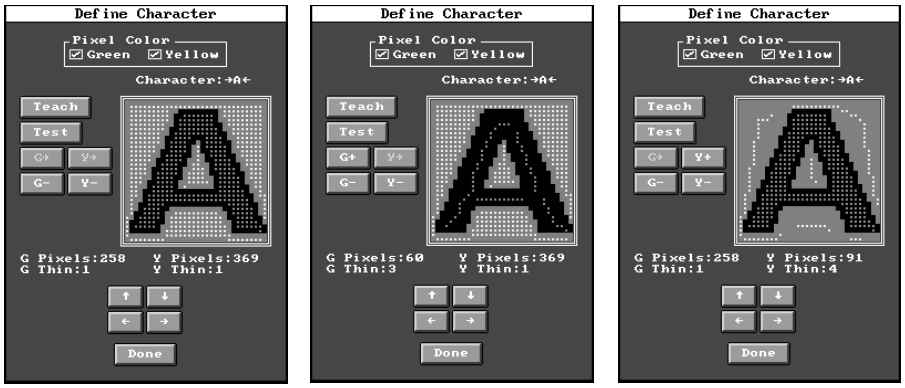
Thinning

Thinning is an erosion and reduction process that erases green and yellow pixels from the edges of the taught character. Thinning is used only for font teaching and editing.

When the Teach function is used, the green and yellow portions of the character pattern are copied from the black and white portions of the printed character image. They are then thinned down based on the **G Thin** and **Y Thin** settings. These settings range from 1 (minimum thinning) to 5 (maximum thinning).



The images below show the effects of modifying the thinning parameters.



Original Taught Image

2 Levels Green Thin
No Yellow Thin

4 Levels Yellow Thin
No Green Thin

The currently selected thinning settings are stored in the font file, so they will remain in effect whenever the **Teach** function is subsequently used for any character in the font.

In the center of the **Define Character** panel, the following information is displayed:

G Pixels

The number that appears after **G Pixels** is the number of green pixels in the character pattern.

Y Pixels

The number that appears after **Y Pixels** is the number of yellow pixels in the character pattern.

G Thin

Shows the current green thin setting. **G+** reduces this by 1 and **G-** increases this value by 1. The range of **G Thin** is 1-5.

Y Thin

Shows the current yellow thin setting. **Y+** reduces this by 1 and **Y-** increases this value by 1. The range of **Y Thin** is 1-5.

HINTS:

- The quality of the overall characters on the part may change over time. If this is the case, the thinning can be changed and the characters re-taught so that the system will be able to read characters at the beginning of a run, as well as characters at the end of a run.
- Using a small number of pixels to represent a character will cause the recognition to be very sensitive since each pixel is a larger % of the total.
- Using a large number of pixels to represent a character will cause the recognition to be less sensitive to print quality changes.

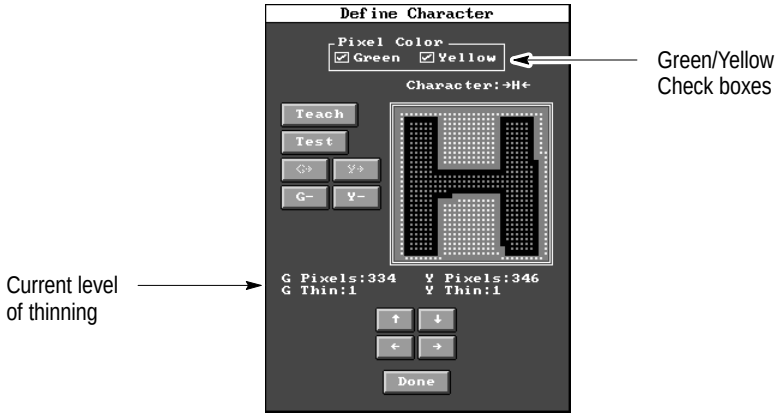
Editing Taught Patterns Manually

You can modify a taught character by changing the green and yellow pixel pattern manually.

To change taught pixel patterns:

1. Click the **Edit** button on the **Edit Font** panel.

   The **Define Character** panel is displayed:



2. Change individual pixel colors:

   To add only green pixels, choose the **Green** check box and uncheck the **Yellow** check box. Add green pixels by clicking the mouse button on the character pattern.

   To add only yellow pixels, choose the **Yellow** check box and uncheck the **Green** check box. Add yellow pixels by clicking the mouse button on the character pattern.

   To delete green and yellow pixels, uncheck both the **Green** and **Yellow** check boxes. Delete pixels by clicking on them with the mouse.

   To add both green and yellow pixels, check both the **Green** and **Yellow** check boxes. As you click the mouse, green or yellow pixels will be entered depending on whether the mouse is on the character image (black pixels) or on the character background (white pixels)

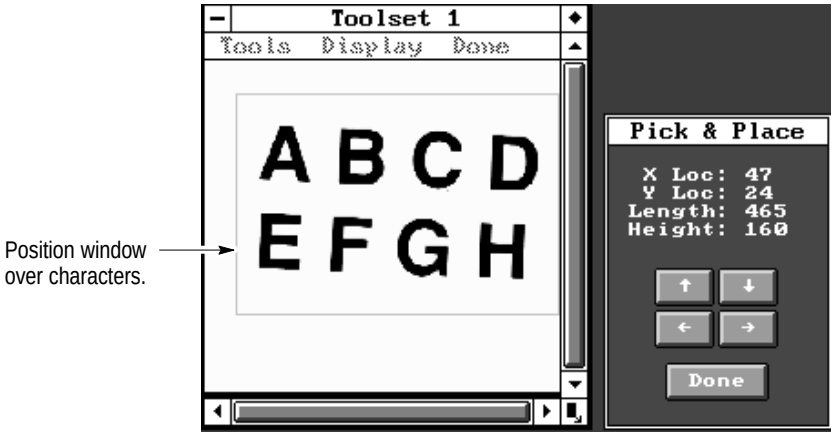
3. Click the **Done** button to exit to the **Edit Font** panel.

Testing Fonts

After you have taught individual characters in a font, you can test the font against individual or groups of characters.

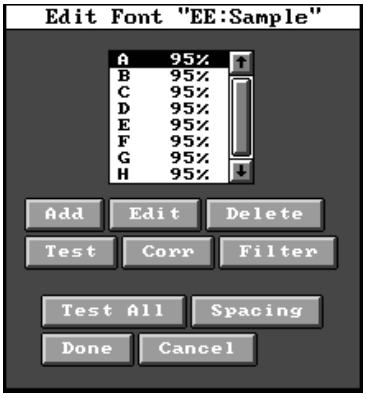
To Test a Font:

1. Return to the **OCR Tool Edit** panel and position the OCR Tool window over the characters to be inspected.



2. Click the **Edit Font** button on the **OCR Tool Edit** panel.

   The **Edit Font** panel is displayed.

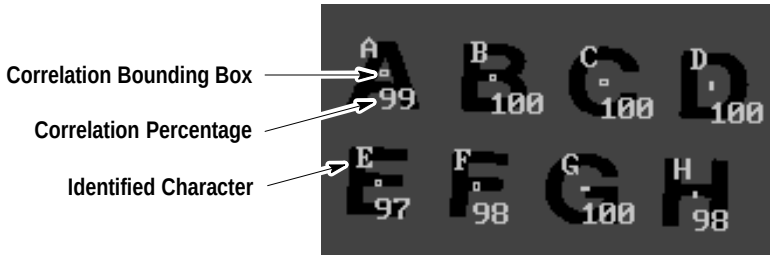


3. Click the **Test All** button on the **Edit Font** panel to test all taught characters.

   Or highlight the character to be tested and click the **Test** button on the **Edit Font** panel.

   The window shows the inspected characters and the characters that have been identified. Each character that has been identified shows:

   - Identified Character
   - Correlation Bounding Box
   - Correlation Percentage

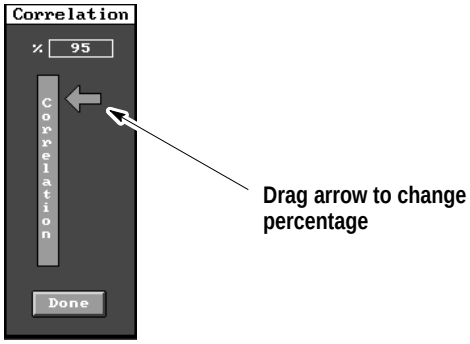


4. If characters are identified incorrectly or not recognized, refer to **Font Optimization** (page 5–16).

Setting Correlation Threshold

The Correlation is the percentage of the pixels required in the inspected character to match the pixels in the taught character. If the percentage of the inspected pixels is greater than or equal to the specified correlation percentage, the inspected character is recognized. The higher the correlation percentage, the closer the inspected character must match the taught character to pass.

Clicking the **Corr** button on the **Edit Font** panel displays the **Correlation** panel:



To change the correlation percentage:

Drag the arrow up or down. Each time the correlation percentage is changed, the **Test** function (See page 5–15) is performed and the characters that correlate are displayed.

Defining Spacing

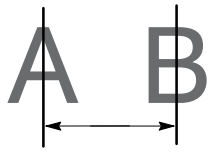
The Spacing settings determine how spaces between characters are handled. The **Character Spacing** must be set to the average distance between the left edges of two consecutive characters, and to the distance between lines of characters. The **Space Dimensions** are used to detect spaces between characters.

In general, the system measures distances ”between” characters as the distance between their *correlation boxes*, which are near the center of the characters.

Character Spacing

Character Spacing consists of 2 dimensions:

- *Horizontal Character Spacing* should be set to the horizontal distance from the center of one character to the next.



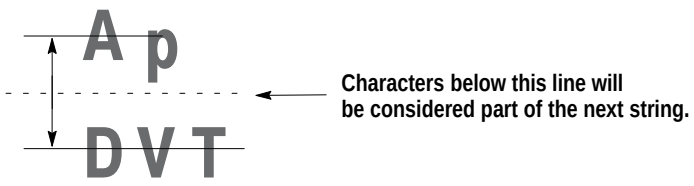
The horizontal character spacing is used to handle spaces in the string of read characters, as follows:

1. When the system detects two adjacent characters and the distance between them is less than 1/2 the horizontal character spacing, the system treats them as two confusion characters in the same location.

2. When the system detects two adjacent characters and the distance between them is greater than 1/2 the horizontal character spacing but less than the horizontal character spacing plus 1/2 the horizontal space dimension, the system treats them as two consecutive characters with no space character in between.

3. When the system detects two adjacent characters and the distance is greater than the horizontal character spacing plus 1/2 the horizontal space dimension, the system treats them as two characters with a space character in between. Only a single space is inserted into the string of read characters, no matter how far apart the characters are.

- *Vertical Character Spacing* should be set to the vertical distance from the center of one line of characters to the center of the next line.



The vertical character spacing is used to separate the characters into multiple lines, as follows:

1. When the system detects two characters and the vertical distance between them is less than 1/2 the vertical character spacing, the system treats them as belonging to the same string of characters.

2. When the system detects two characters and the vertical distance between them is greater than 1/2 the vertical character spacing, the system treats them as belonging to different strings of characters.

Gray Spaces

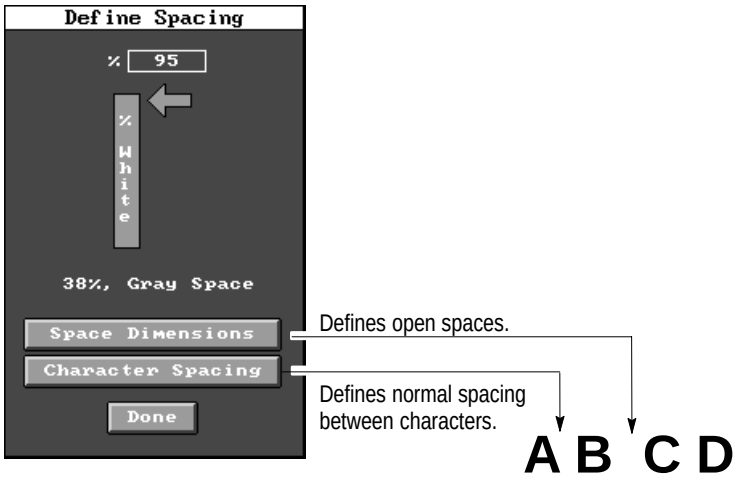
When **Gray Spaces** are enabled, the **Space Dimensions** are used as follows:

When the system detects a space between characters, it measures the percentage of white pixels within a box located in the region of the space. If this percentage is more than the Gray Space percentage, the system treats it as a true ”white” space. Otherwise, it treats it as an unrecognized character, or ”gray” space. In this case the gray space character “_” will be inserted into the string of read characters.

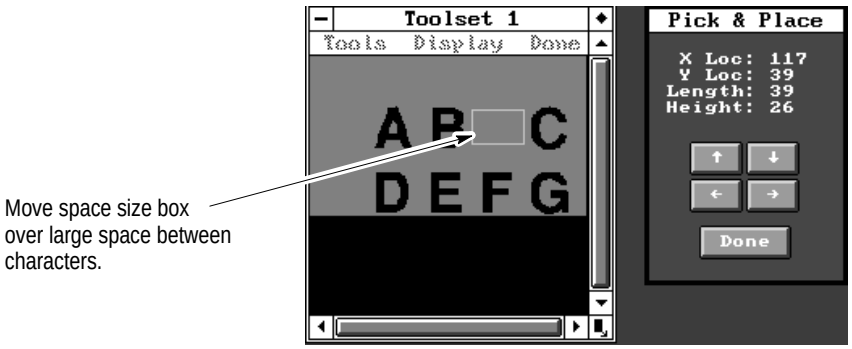
To define spacing:

1. Click the **Spacing** button on the **Edit Font** panel.

   This displays the **Define Spacing** panel.

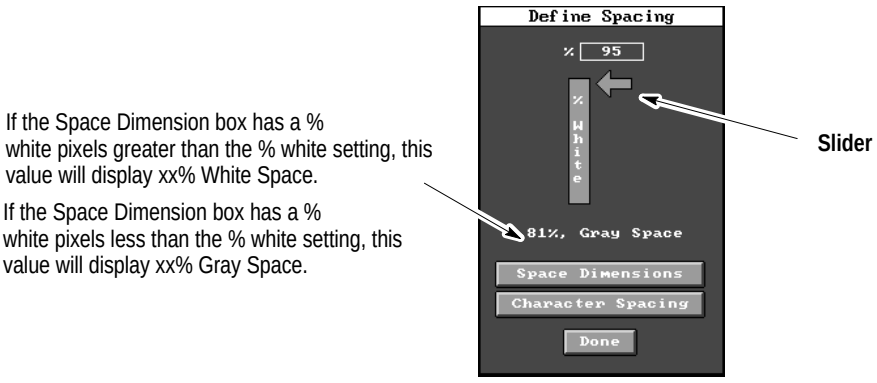


2. Click the **Space Dimensions** button. This displays the **Pick and Place** panel.
3. Pick and place the **Space Dimensions** box over an open space between characters. The length and height must be between 8 and 64 pixels. The default size is 20 x 20.



4. After the space box is properly positioned, click the **Done** button.

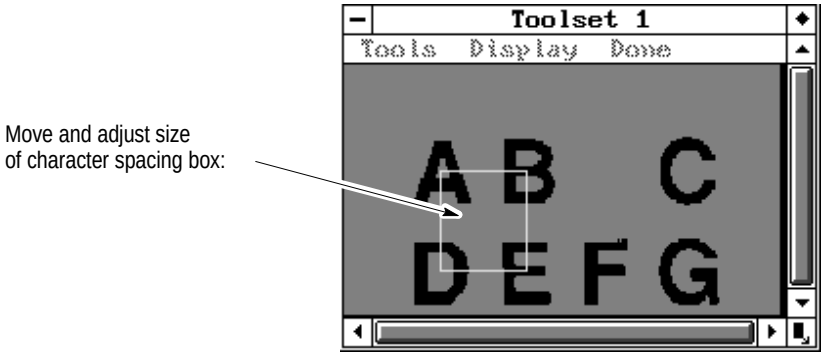
5. Adjust the percentage of white required in a white space using the slider. You can also change the percentage by clicking the % field and entering a new value using the calculator.


If the Space Dimension box has a % white pixels greater than the % white setting, this value will display xx% White Space.
If the Space Dimension box has a % white pixels less than the % white setting, this value will display xx% Gray Space.
Define Spacing
% 95
% White
Slider
81%, Gray Space
Space Dimensions
Character Spacing
Done

6. Click the **Character Spacing** button to set the horizontal and vertical space between characters.

   This displays the **Pick and Place** panel.

7. Move and size the character spacing box so that it is positioned as shown below. The length and height must be between 8 and 64 pixels. The default size is 28 x 28. If the lines of printed characters are more than 64 pixels apart, set the height of the **Character Spacing** box to 64.



8. Click the **Done** button to exit define spacing function.
9. Return to the OCR Tool Edit Panel to see if the spaces are recognized properly.

Font Optimization

The most important aspect of creating inspection fonts is font optimization, where the patterns and settings of individual characters are adjusted for best performance. The success of an OCR application depends on correctly setting up the font to recognize characters despite image variations and print degradation, and to eliminate confusion between different characters that are similar in appearance. The following guidelines are intended to assist you in setting up an OCR application.

Reducing Image Variations

Variations in the acquired image make it more difficult to accurately recognize characters. The following types of image variation occur:

- Lighting variations
  Variations in the lighting across the field of view should be minimized through careful lighting design. Variations in brightness from one image to the next, due to light source intensity variation, can be reduced by using the **light probe**. Refer to the CVIM2 Reference Manual for a description of light probe operation.

  Important: Variations in brightness can also compensated for by using the CVIM2 Image Tool to preprocess the image for the OCR Tool. Refer to Appendix B for more information.

- Blurring due to motion
  Blurring can cause the characters to become elongated in one direction. This can be a problem particularly if the degree of blurring varies. Blurring should be reduced or eliminated by using strobe lighting or electronic shutter cameras.

Handling Print Degradation

Different printing processes introduce different forms of degradation or variation into the printed characters. Some common printing problems are:

- Broken characters
  When part of a character is missing, this reduces its degree of correlation with the taught character pattern. Usually, characters that are partially printed should be rejected. However, the system can be configured to accept some degree of broken characters. This is accomplished by adjusting the correlation percentage.
- Changes in character shape
  Some printing processes introduce changes in the shape of the characters. The system will recognize characters that vary in shape if there is a sufficiently wide border of don't-care pixels around the edge of the character in the taught character pattern. If the variation in character shape is extreme, the system will not be able to recognize the characters.

- Variations in print density
  Changes in print density can reduce the contrast between characters and the background. This is usually not a problem if sufficient contrast exists in the first place, which can be achieved by ensuring that the lighting is even across the field of view, and by adjusting the camera's light references.

  Important: Variations in print density can also compensated for by using the CVIM2 Image Tool to preprocess the image for the OCR Tool. Refer to Appendix B for more information.

  When the characters become darker or lighter, the characters in the thresholded image tend to grow or shrink. The system will accommodate this if there is a sufficiently wide border of don't-care pixels around the edge of the character in the taught character pattern.

- Size changes
  Minor changes in character size can be accommodated by leaving a sufficiently wide border of don't-care pixels around the edge of the character in the taught character pattern. Major changes in character size require changing the character size of the OCR Tool using the Rescale option, and cannot be accommodated from one image to the next.
- Smudges
  Smudges appear as extra ink or dark material in the region of the characters. Major smudges will be rejected, but the system can allow for minor smudges if the character correlation percentage is reduced.
- Background contrast changes
  Often when a product changeover occurs, the material on which the characters are printed changes. If the change in contrast is too large, it may be necessary to adjust the OCR Tool's threshold. This can be performed during a changeover, but not from one image to the next.

  Important: Background contrast changes can also compensated for using the CVIM2 Image Tool to preprocess the image for the OCR Tool. Refer to Appendix B for more information.

If the OCR Tool fails to recognize a character:

When the system fails to recognize a printed character, it is because the printed character differs substantially from the character used to teach the character pattern. If this occurs, the following procedure should be followed:

1. Obtain a frozen image containing the character that is not recognized. If the system is in run mode, exit run mode and enter setup mode.
2. Open the Toolset Edit panel and edit the OCR Tool.
3. Use the **Threshold/Filter** option to verify that the threshold is acceptable for the image. If not, adjust the threshold so that the characters are well separated from the background. If minor threshold adjustments are not sufficient, it may be necessary to reduce the brightness variation of the image.
4. Select the **Character Size** option, and verify that the character size is set correctly for the characters. If not, adjust the character size (Refer to page 4–12 for a description of character size adjustment).
5. Select the **Edit Font** option and edit the character that is not recognized.
6. Use the **Test** option to determine whether the character correlates. If it does not correlate at all, make sure that the character is not too close to the edge of the OCR Tool's processing window.
7. Place the character teach box around the printed character in the image. Use the arrow buttons to finely adjust the position so that the character is aligned as well as possible with the taught pattern.
8. Observe the areas where the printed character differs from the taught pattern. Usually this will be around the edges of the character. By placing more don't-care pixels in this region, the system can be made more tolerant of variations.
9. If the variation in the printed character is too great to accommodate by adding additional don't-care pixels to the taught character pattern, you can make the system more tolerant of variations by decreasing the correlation percentage of the taught character.

Eliminating Confusion

When a printed character correlates with two or more different taught character patterns, it is called a *confusion character.* In general, confusion between similar characters is reduced by placing more pixels in the areas of the pattern where the characters differ, and fewer pixels in the areas of the pattern where the characters are the same. This increases the *significance of the differences.*

The following are some examples of pairs of characters that are sometimes confused because they are similar in shape, and adjustments that may reduce the confusion. In nearly all cases, large regions filled with yellow pixels should first be thinned out, so that only the border remains.

- B and 8
  Confusion can be reduced by placing more green pixels in the upper-left and lower-left corners of the B, as well as in the left-center region. Place more yellow pixels in the corresponding regions of the 8.
- C and O
  Confusion can be reduced by placing more yellow pixels in the gap on the right side of the C.
- E and F
  These some times get confused because the lower bar of a printed E may fall in a region of the F pattern where there are don't-care pixels. Make sure that the F pattern has sufficient yellow pixels along the bottom.
- I and B/D/E/F/H/K/L/M/N/P/R/T/U
  In some fonts, the uppercase I is just a vertical line, which easily correlates with parts of other characters containing vertical lines. Confusion can be eliminated by placing sufficient yellow pixels to the sides of the I pattern. It is also often necessary to increase the required correlation percentage for the I character.
- O and Q
  The difference between O and Q is very minor in some fonts. It is generally necessary to place as many green pixels as possible in the serif of the Q, while still allowing for some variation of the character border. It is also often necessary to reduce the number of green pixels in the circular portion of the O and Q.
- V and W
  In some fonts, a printed W character may be incorrectly read as two V's. This problem can be eliminated by placing sufficient yellow pixels in the upper-left and upper-right portions of the V pattern.

If a printed character correlates with two or more taught patterns:

When a printed character correlates with two or more taught patterns, it is because the printed character is similar to other characters in the font. If this occurs, the following procedure should be followed:

1. Obtain a frozen image containing the character that is confused. If the system is in run mode, exit run mode and enter setup mode.
2. Open the Toolset Edit panel and edit the OCR Tool.
3. Use the **Threshold/Filter** option to verify that the threshold is acceptable for the image. If not, adjust the threshold so that the characters are well separated from the background. If minor threshold adjustments are not sufficient, it may be necessary to reduce the brightness variation of the image.
4. Select the **Character Size** option, and verify that the character size is set correctly for the characters. If not, adjust the character size (Refer to page 4–12 for a description of character size adjustment).
5. Select the **Edit Font** option and use the **Test All** option to determine which taught characters correlate with the printed character. If there are too many correlations displayed in the same location, you must **Test** each potential confusion character individually.
6. Edit the taught character that is confused with the printed character.
7. Place the character teach box around the printed character in the image. Use the arrow buttons to finely adjust the position so that the character is aligned as well as possible with the taught pattern.
8. Observe the regions of the taught character pattern that are the same as the printed character. Place more don’t-care pixels in these regions because they do not contribute information to help distinguish the characters. This will increase the relative significance of the areas that are different.
9. Observe the regions of the taught character pattern that contain don’t-care pixels, where the shapes of the original characters are different. Add additional green or yellow pixels in these regions to reduce the percentage that will match the confusion character.
10. Again use the **Test** option to determine the effect of the changes you have made to the taught character pattern. The correlation percentage should be reduced. Repeat steps 8 and 9 to reduce the correlation as much as possible.

When the **Test** option is used, characters which correlate at or above the set correlation percentage are shown in green. Characters that correlate at or above 97.5% of the set correlation percentage are shown in yellow, and characters which correlate at or above 95% of the set correlation percentage are shown in red.

When eliminating confusion, it is best to modify the character pattern so that no correlations with confusion characters are displayed in green, yellow or red when the Test option is used. It is in some cases acceptable to have some red correlations displayed, as these are usually distinguishable from valid correlations.

If you cannot eliminate yellow correlations with confusion characters by modifying the template, they can be eliminated by increasing the character's correlation percentage. This may reduce the system's tolerance of printing variations however.

Working With Font Files

A font used by an OCR Tool is stored in a font file. After you create a font file, you can copy, rename or delete it using the **Filer**. Refer to the CVIM2 Reference Manual for more information on the filer and on file device usage.

Storage of Font Files
Normally, font files are stored on the EE: device when they are first created. This allows for easy modification of the file, because the EE: device can be rewritten without the need for the Recycle operation. Other storage devices such as V2: have a larger capacity than the EE: device, so it may be desirable to move font files to V2: after they have been created and optimized.

Moving or Renaming Font Files
If a font file is moved to a different device, or if the file name is changed, then all OCR Tools that use the font must be modified to reflect the new file name.

Sharing Font Files
You can configure several OCR Tools to share the same font file simply by giving them the same **Font Name**. This conserves on-line memory, file storage space, and font teaching effort. Each tool can have a different character size, threshold, etc.

Chapter 6

Using Match Strings

Chapter Objectives

This chapter describes:

- Match string usage
- Metacharacters
- Testing match strings
- Example match strings

Important:
This chapter describes match strings of OCR Tools. These match strings often contain spaces, they are represented by a square character: □

Match strings are displayed in the OCR Tool Edit panel and on the string-entry keyboard delimited by arrows at the left and right ends. Spaces are displayed on the CVIM2 screen as actual spaces rather than as the character shown above.

Match String Usage

When Optical Character Verification (OCV or OCV Strict) mode is selected for a given string, the OCR Tool compares the read text to a user-specified match string. Match strings can be used in the following ways:

- Verify that the read text matches exactly
  If no metacharacters are used, the text read by the OCR Tool must match the match string exactly.
- Allow extra characters at the beginning or end
  Metacharacters can be used to allow the tool to pass if extra characters appear before or after the desired text.
- Verify that the read text matches one of several valid sequences
  This can be used, for example, to verify that a 3-letter code represents a valid month of the year.
- Verify that a particular type of character appears in a certain position
  Metacharacters can be used, for example, to specify that a string must consist of three digits followed by three letters.

Length of Match Strings

Although each string of an OCR Tool can only read up to 20 characters, its match string may be up to 80 characters long. This allows for relatively complex matching capability using metacharacters.

Leading & Trailing Spaces

If there is sufficient room within the OCR Tool's processing window, the tool will check for spaces in the regions immediately before and after each string, and will add either a white space or gray space to the beginning and end of the read text. If the characters which correlate are too close to the left and/or right edges of the processing window, then no white or gray space will be added to the beginning and/or end of the read text. See page 2–6

In some applications, an inspected character string would be acceptable whether or not there was sufficient room to check for spaces before and after the string. In this case, the match string should begin and end with the sequence □**?** to indicate that a space is optional.

Metacharacters

The CVIM2 OCR package provides a complete set of special purpose characters, called *metacharacters*, which you can use to construct match strings. A metacharacter is used to match a sequence of one or more characters which can vary from inspection to inspection.

A listing of valid metacharacters appears in the table below. Each appears with a general explanation of its function and syntax. More detailed examples of their use appear at the end of this chapter.

While the individual metacharacters perform easily understood actions, combining and nesting them will quickly create extremely complex logical expressions. Be sure to thoroughly test your expressions using the **Test Match** function, to make certain your match strings perform as you expect them to under the conditions you are liable to experience.

Metacharacters can be entered with the keyboard or by selecting the metacharacter buttons above the keyboard. The metacharacter buttons include:

[A-Za-f]	Any alpha
[0-9]	Any number
?	0 or 1 occurrences of the preceding character
*****	0 or more occurrences of the preceding character
+	1 or more occurrences of the preceding character
|	OR operation

Table 6.A
Search Pattern Metacharacters - Wildcard

Character	Description and Use
.	The *period* represents any single character, and is used as a single-character "wildcard".

Table 6.B
Search Pattern Metacharacters - String Manipulation

Character	Description and Use
	Note: These metacharacters refer to the character, metacharacter, string, or expression that immediately precedes them.
?	The *question mark* matches either **no occurrence** or **one occurrence** of what precedes it. This metacharacter is used in a search string where the character may not appear at all, or may appear once.
+	The *plus sign* matches **one or more occurrences** of what precedes it. This metacharacter is used in a search string where the character will be present, but you are unsure how many times it appears.
*****	The *asterisk* matches **none or more occurrences** of what precedes it. This metacharacter is used in a search string in cases where the character *may not* appear, or *may appear one or more times.*

Table 6.C
Search Pattern Metacharacters - Logical Operators and Other Special Functions

Character	Description and Use
[ ]	*Square brackets* ([ ]) match any single character enclosed within the brackets. A range of values can be represented within the brackets by separating the first and last characters in the range by a hyphen. Square brackets must be used in pairs. **Note:** The *circumflex* (^) can be used as the first character within the square brackets to match any character which is *not* enclosed within the brackets. **Examples** [ABC] Matches “A”, “B”, or “C” [L-P] Matches “L”, “M”, “N”, “O”, or “P” [0-9] Matches “0”, “1”, “2”, “3”, “4”, “5”, “6”, “7”, “8”, or “9” [^A-Z] Matches any character that is **not** upper case alphabetic
( )	*Parentheses* can be used in match strings to group characters and metacharacters to form expressions. Parentheses must be used in pairs. **Example** (AB)+ The plus sign applies to the expression (AB). Strings that would match this expression include: “AB”, “ABAB”, and “ABABAB”. **Note:** Parentheses may be nested to form complex expressions.
|	A *vertical bar* (the shifted “\” character on the keyboard) matches either the character or expression on the left **or** right of the vertical bar. **The vertical bar should always appear within a set of parentheses.** **Examples** (A | B) Matches “A” or “B” (abc|123) Matches “abc” or “123”
****	The *backslash* indicates that the following character, which would normally be interpreted as a metacharacter, should instead be interpreted as a literal ASCII character. **Example** \+ The plus (+) will be interpreted as a plus rather than as a metacharacter.

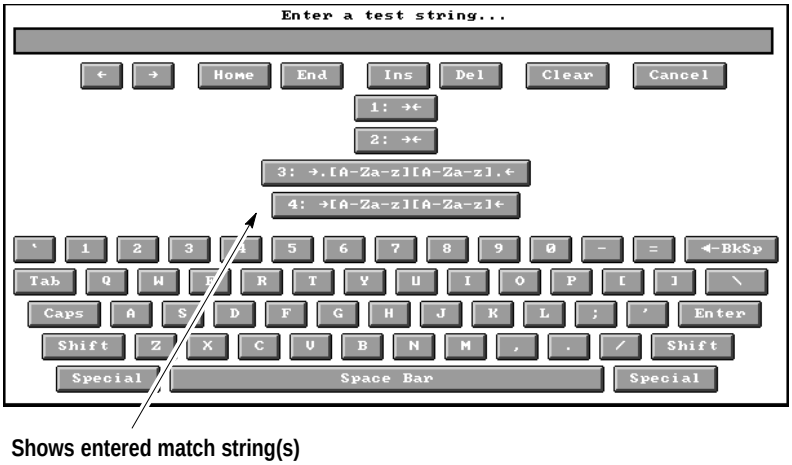
Testing Match Strings

After entering a match string, you can test it by entering a string of text to be matched against the match string. This is particularly useful if you are using metacharacters.

To test a character string:

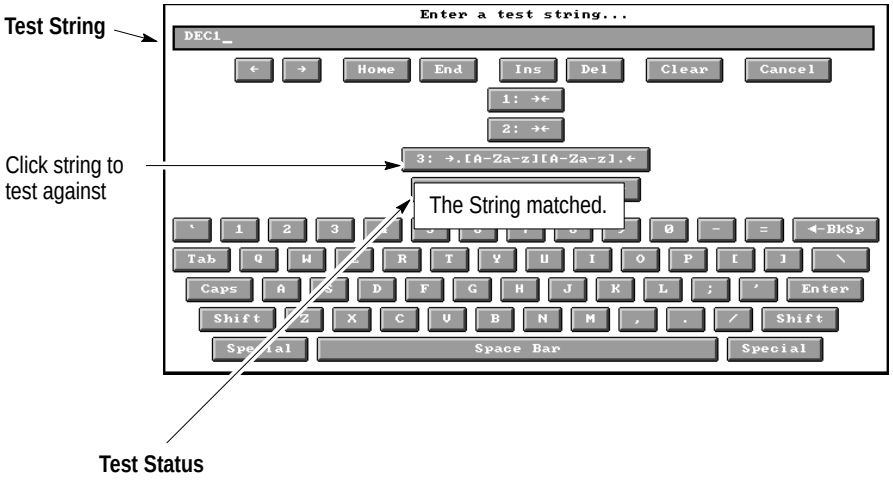
1. Click the **Test Match** button on the **OCR Tool Edit** panel.

   The test match keyboard appears:



2. Enter the string you want to test using the keyboard.
3. Click the string you want to test against.

   A message is displayed indicating whether or not the string matched.



4. Press Enter to return to the **OCR Tool Edit** panel.

Match String Examples

The following are examples of match string operations. For each match string in the left column, the center column shows examples of strings which would match, and the right column shows examples of strings which would not match.

This match string	Matches this:	But not this:
ABC	ABC	ABCD □ABC ABC□ □ABC□
A.C	AAC ABC A7C A□C A_C A?C	AC ABCD AXBC
□?ABC□?	ABC □ABC ABC□ □ABC□	ABCD
Serial□#[0-9]+	Serial□#1 Serial□#534 Serial□#884773883878	Serial□#53A Serial□575 Serial□#
X*$100	$100 X$100 XXXXXXXXX$100	Y$100 XXX□XXX$100 $100XXX
ABC[01234][0-9][0-9]	ABC123 ABC495 ABC001	ABC12 ABC558A ABC834 ABC□159
(Lot□)?157	157 Lot□157	Lot157 Batch□157 Lot□158
(JAN|FEB|MAR|APR)	JAN FEB MAR	JUN JUL AUG
10\.554	10.554	10□554 10\.554
(P[0-9]□)*P7	P7 P5□P6□P7 P1□P1□P3□P0□P5□P1□P7	P6 P4□P5□P6 P6□P7□P8□P9 P13□P7

□ = space

Chapter 7

On-Line Operation

Chapter Objectives

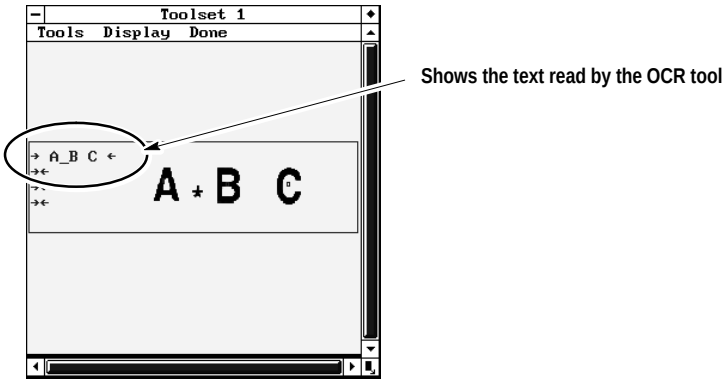
This chapter describes:

- Inspection Displays of the OCR Tool
- On-line adjustment of the OCR Tool

Inspection Displays

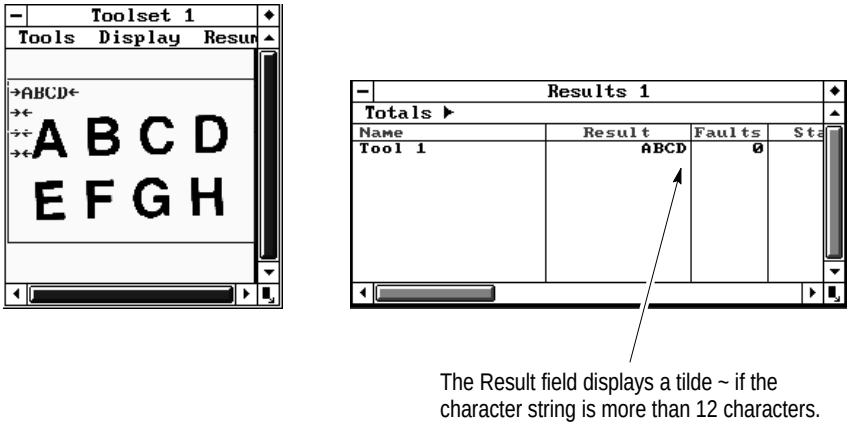
Refer to the CVIM2 Reference Manual for a complete description of on-line operation and displays. The following section describes the unique aspects of OCR Tool displays.

The on-line tool display of the OCR Tool shows the strings which are read in the upper-left corner of the processing window of the tool. Each string is delimited by arrows, so that leading and trailing spaces are visible.

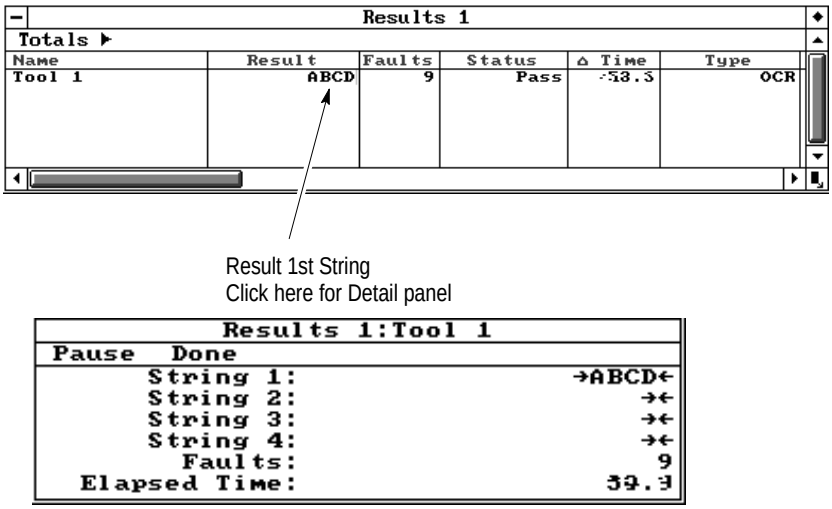


The position of each character's correlation box (the location where the character correlated) is indicated by a small square within the tool's processing window. The color of the tool will be green or red to indicate the PASS or FAIL status of the tool.

In the toolset results panel, the first string read by the OCR Tool is shown in the Result column. If the character string is more than 12 characters long, only the first 12 characters are shown, followed by a tilde (~) character.



If you click on the OCR Tool Result, the detail panel for the OCR Tool will be displayed. This shows the results of the individual strings read by the tool, the number of faults (failures) the tool has recorded, and the inspection time in milliseconds. Each of the four strings will be displayed in red in the detail panel if it fails its match condition.

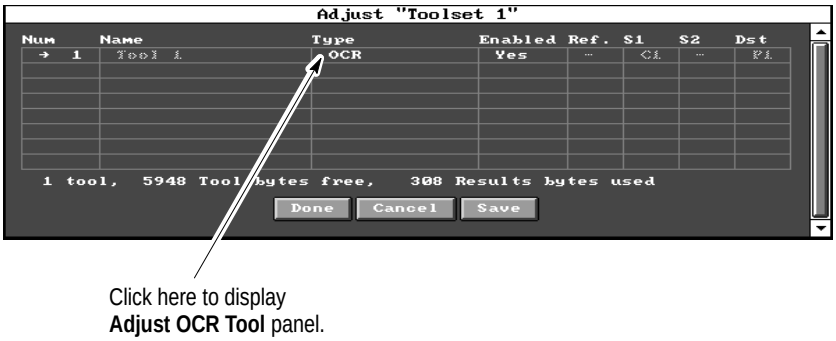


On-Line Adjustment

To make adjustments to the inspection process while on-line:

1. Choose the **Tools** menu from the toolset image display panel.

   This displays the **Adjust Toolset** panel.



Click here to display
Adjust OCR Tool panel.

2. Click in the type box for the OCR Tool on the **Adjust Toolset** panel to bring up the **Adjust OCR Tool** panel.

   When on-line, you can adjust the same options available during configuration except:

   - The Font cannot be changed or edited while on-line.
   - Character Size cannot be adjusted.
   - The size of the OCR Tool's processing window cannot be increased.
   - The Thresh/Filter settings of the tool can be adjusted, but no processed image will be displayed.

3. Click the **Done** button on the **Adjust OCR Tool** panel. On the **Adjust Toolset** panel, click the **Save** button to save your changes in the tools file, then the **Done** button to apply the changes to the next inspection.

Chapter 8

Communications and Results Processing

Chapter Objectives

This chapter describes how to:

- Access individual results of an OCR Tool
- Obtain OCR Tool inspection results through communications
- Access OCR Tool inspection results via Math tools
- Adjust OCR Tool parameters through communications
- Upload and download font files

For more information about CVIM2 communications and Math tools, refer to the CVIM2 Reference Manual and the CVIM2 Communications Manual.

OCR Inspection Results

The OCR Tool makes its inspection results available to other components of the CVIM2 system. This makes it possible to communicate OCR data to the outside world, and to perform mathematical calculations on numeric values read by OCR.

The following inspection results can be accessed by Math tools, and through the CVIM2 serial ports, Remote I/O port, and discrete outputs:

- OCR Tool status (pass or fail)
- Status of individual strings (pass or fail)
- Text read in individual strings of an OCR Tool (*not* via discrete outputs)

The following table shows the inspection results available for an OCR Tool. The **Inspection Result** names are used by the Math tool, Communications Message Editor, and Discrete I/O Editor.

Inspection Result	Definition & Usage	Field Type
Pass	1 if the OCR Tool passes. 0 if the tool fails.	Uword
Warn	Always zero.	Uword
Fail	Fail code: [3] 0 = PASS 9472 = No binary correlator coprocessor installed 9473 = No font assigned, or font could not be loaded 9474 = No characters present in the font 9475 = Match fail or no characters recognized (Refer to CVIM2 Communications Manual Appendix C for additional Fail codes which pertain to *any* CVIM2 tool).	Uword
String 1	Result string #1. [1]	String [2]
Fail 1	Result string #1 Fail code: [1][3] 0 = PASS 9475 = Match fail or no characters recognized	Uword
String 2	Result string #2. [1]	String [2]
Fail 2	Result string #2 Fail code (see Fail 1).	Uword
String 3	Result string #3. [1]	String [2]
Fail 3	Result string #3 Fail code (see Fail 1).	Uword
String 4	Result string #4. [1]	String [2]
Fail 4	Result string #4 Fail code (see Fail 1).	Uword

[1] String # and Fail # results are only available for a given string if the string's **Mode** is not **Disabled**.

[2] When accessing OCR data using the math tool, strings are converted to numbers. See **Accessing OCR Results from Math Tools** in this chapter for details.

[3] If the tool's fail code is anything other than this, it indicates an error condition in which the tool cannot be processed. In this case, Fail 1 through Fail 4 are invalid, and usually set to zero.

Communications Messages

Communications messages are used to transmit inspection results via the serial ports or Remote I/O port. Refer to the CVIM2 Communications Reference Manual for a complete description of the Communication Message Editor.

Any of the OCR Tool results shown in the preceding table can be used in a communications message.

Note:
Each result field of a communication message contains **Field** (field width) and **Prec** (precision) settings which determine how the result is formatted. For numeric values, the precision specifies the number of digits past the decimal point, and defaults to zero. When a String result is to be included in a message, the precision must be set to the maximum number of characters expected in the string. The field setting should be equal to or greater than the precision.

Set **Prec** to the same value as **Field** for OCR Strings.

Accessing OCR Results from Math Tools

The Math tool can access any of the results of the OCR Tool. The numerical Fail codes are simply accessed as numbers. When a Math tool accesses a String result, the string is first converted to a number.

When a String result is converted to a number, only the left–most sequence of digits (and an optional minus and decimal point) is converted. Any other characters are ignored. For example:

This string result:	Is converted to this value:
–123.78	–123.78
123ABC	123
–57.5x21.4	–57.5
Part 575	0

OCR Tool Adjustment

When the CVIM2 is on–line, parameters of the OCR Tool can be adjusted through the serial and Remote I/O ports using the **tooladj** command.

tooladj "Toolset 1.Lot " ms1 "Lot0123"

Command **Token** **Data Sent**

Refer to the CVIM2 Communications manual for information on using the **tooladj** command.

You can adjust the following parameters of the OCR Tool.

Command Description	Token	Example
Tool Enable (Status = Y or N)	E *status*	tooladj "Toolset 1.Tool 1" E Y
Absolute Position (upper left corner of window)	ap *x y*	tooladj "Toolset 1.Tool 1" ap 50 50
Delta Position	dp *dx dy*	tooladj "Toolset 1.Tool 1" dp 5 5
Threshold	t *hi lo*	tooladj "Toolset 1.Tool 1" t 255 67
Delta Threshold	dt *dhigh dlow*	tooladj "Toolset 1.Tool 1" dt 0 –3
Run Alpha (Status = Y or N)	ra *status*	tooladj "Toolset 1.Tool 1" ra Y
Run Numbers (Status = Y or N)	rn *status*	tooladj "Toolset 1.Tool 1" rn N
Run Symbols (Status = Y or N)	rs *status*	tooladj "Toolset 1.Tool 1" rs Y
Run Spaces (Status = Y or N)	rp *status*	tooladj "Toolset 1.Tool 1" rp Y
Align (Status = Y or N)	a *status*	tooladj "Toolset 1.Tool 1" a Y
Mode of String #1 Mode { 0 = Disabled, 1 = OCR Strict, 2 = OCR, 3 = OCV Strict, 4 = OCV }	m1 *mode*	tooladj "Toolset 1.Tool 1" m1 0
Mode of String #2 Mode { 0 = Disabled, 1 = OCR Strict, 2 = OCR, 3 = OCV Strict, 4 = OCV }	m2 *mode*	tooladj "Toolset 1.Tool 1" m2 4
Mode of String #3 Mode { 0 = Disabled, 1 = OCR Strict, 2 = OCR, 3 = OCV Strict, 4 = OCV }	m3 *mode*	tooladj "Toolset 1.Tool 1" m3 2
Mode of String #4 Mode { 0 = Disabled, 1 = OCR Strict, 2 = OCR, 3 = OCV Strict, 4 = OCV }	m4 *mode*	tooladj "Toolset 1.Tool 1" m3 3
Match String #1	ms1 *string*	tooladj "Toolset 1.Tool 1" ms1 "Lot3"
Match String #2	ms2 *string*	tooladj "Toolset 1.Tool 1" ms2 "DEC"
Match String #3	ms3 *string*	tooladj "Toolset 1.Tool 1" ms3 "A"
Match String #4	ms4 *string*	tooladj "Toolset 1.Tool 1" ms4 "Date"

Command Description		Token	Example
Subset #1	0 = All 1 = Left 2 = Right	s1 *subset*	tooladj "Toolset 1.Tool 1" s1 2
Subset #2	0 = All 1 = Left 2 = Right	s2 *subset*	tooladj "Toolset 1.Tool 1" s2 0
Subset #3	0 = All 1 = Left 2 = Right	s3 *subset*	tooladj "Toolset 1.Tool 1" s3 1
Subset #4	0 = All 1 = Left 2 = Right	s4 *subset*	tooladj "Toolset 1.Tool 1" s4 2
Length #1		l1 *length*	tooladj "Toolset 1.Tool 1" l1 10
Length #2		l2 *length*	tooladj "Toolset 1.Tool 1" l2 5
Length #3		l3 *length*	tooladj "Toolset 1.Tool 1" l3 9
Length #4		l4 *length*	tooladj "Toolset 1.Tool 1" l4 7

Sending Match Strings with Backslashes

When sending match strings with the **tooladj** command, the backslash (\) is a special command character. To send a match string containing a backslash, the command must have 2 consecutive backslashes.

Examples:

To set the first match string to **ABC\?**, you would use the following tooladj command:

```
tooladj "Toolset1.Tool 2" ms1 "ABC\\?"
```

To set the first match string to **ABC**, you would use the following tooladj command:

```
tooladj "Toolset1.Tool 2" ms1 "ABC\\\\"
```

Transferring Font Files

Font files can be transferred to and from remote devices via RS–232 or Remote I/O. Refer to the CVIM2 Communications Reference Manual for a complete description of file transfers.

Appendix E of the CVIM2 Communications Reference Manual lists the file type codes used for standard file types of the CVIM2. OCR font files use the file type code 'o' (lowercase O).

Type Code	File Type
o	OCR Font file

When a new font file is transmitted to the CVIM2 while it is on–line, the font file will not be used by any OCR Tools until the CVIM2 is taken off–line and then back on–line again.

Appendix A

Status and Warning Messages

The following messages or codes may be displayed during OCR tool setup or results display.

Status Code (Hex)	(Dec)	Fatal	Text	Conditions
0x2500	9472	No	Binary correlator not installed.	Daughter board not installed or incorrect version.
0x2501	9473	No	No font defined.	OCR Tool has no font assigned.
0x2502	9474	No	No characters defined.	No characters are learned in this font.
0x2503	9475	No	Match string failed.	OCV match failed or no characters recognized.
0x2504	9476	No	Auto character sizing failed.	Auto character size failed.
0x2505	9477	No	Bad regular expression.	Match string is illegal.
0x2506	9478	No	No suitable characters.	No suitable characters found for auto character size.
0x2507	9479	No	Font file revision error.	Font file revision error.
0x2508	9480	No	Font file read error.	Font file cannot be opened for read.
0x2509	9481	No	Font file write error.	Font file cannot be written.
0x250A	9482	No	Tool scales modified.	Scale factors were limited to 1024 pixel limit.
0x250B	9483	No	Has the character size been configured?	Character size has not yet been configured.
0x250C	9484	No	OCR Tool installation error.	OCR Tool installation error.

Appendix A
Status and Warning Messages

Appendix A
Status and Error Messages

Appendix B

Compensating for Lighting Variations

Objectives

This appendix describes how to use CVIM2 Image Tools to compensate for variations in lighting.

Using Image Processing

Variations in the lighting across the field of view or image to image brightness variation can make it difficult to recognize characters. The effect of these variations can be reduced by using the CVIM2 module Image Tools to preprocess the image before recognizing the characters with the OCR Tool. This appendix describes two methods that provide this type of compensation. These methods also provide moderate compensation for background color change and changes in print density.

Method 1 – Maximum Compensation

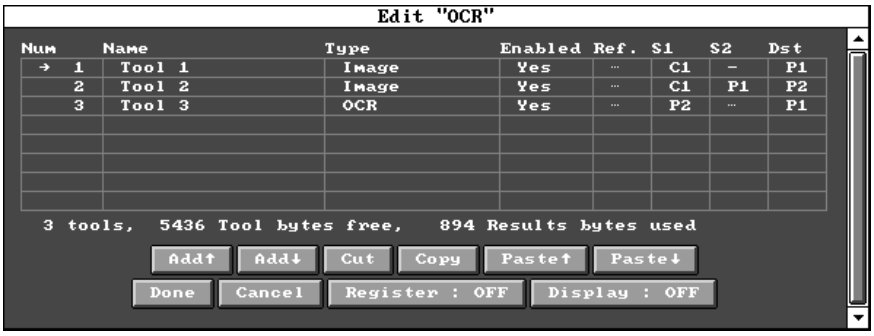
The maximum compensation for lighting variation is accomplished using two Image Tools that compensate for changes in the angle and brightness of the light:

- The first Image Tool filters out the characters to produce a brightness reference image.
- The second Image Tool subtracts the brightness reference image from the original camera image to produce a compensated image for the OCR Tool.

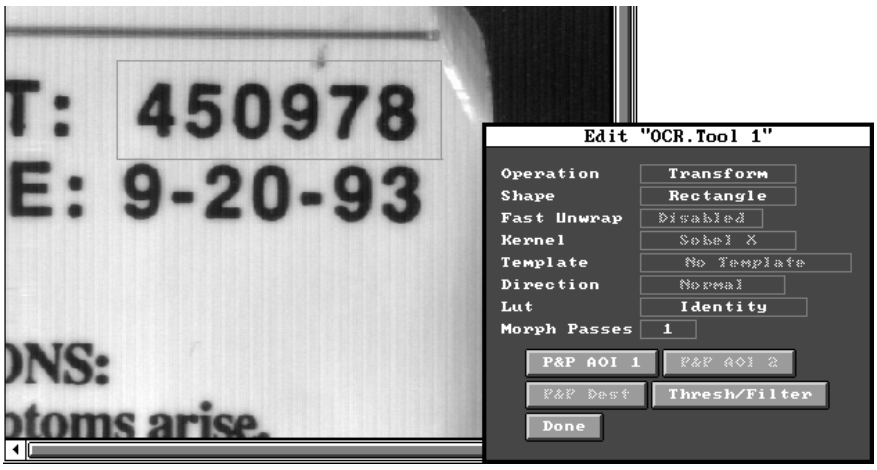
Note: Refer to the CVIM2 Reference Manual (Publication No. 5370-801) for more information on Image Tool operation.

To setup the Image Tools for maximum compensation:

1. Add tools to the toolset as shown below. Note the S1, S2, and Dst settings.


Edit "OCR"
Num Name Type Enabled Ref. S1 S2 Dst
→ 1 Tool 1 Image Yes ... C1 - P1
2 Tool 2 Image Yes ... C1 P1 P2
3 Tool 3 OCR Yes ... P2 ... P1
3 tools, 5436 Tool bytes free, 894 Results bytes used
Add↑ Add↓ Cut Copy Paste↑ Paste↓
Done Cancel Register : OFF Display : OFF

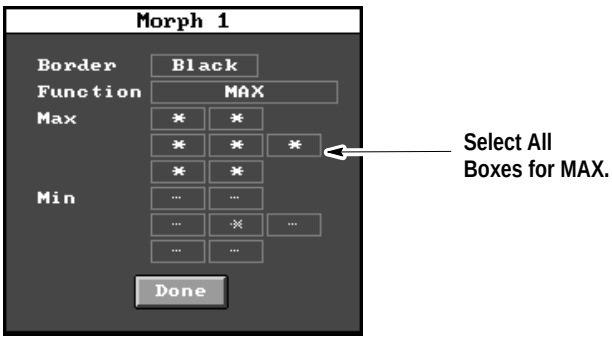
2. Set Tool 1 as shown below. Use the **P&P AOI 1** to position the window around the character string(s) to be read.



3. Record the X, Y, Length, and Height of the Tool 1 window for later use.

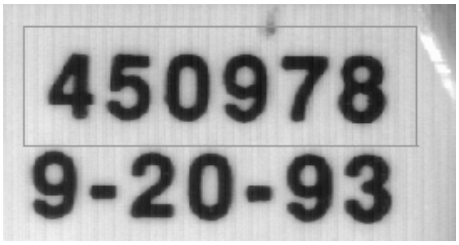
X = _____
Y = _____
Length = _____
Height = _____

4. Select **Thresh/Filter** to setup the Morphology filters. Setup Morph 1 and Morph 2 to perform a MAX operation as shown below:

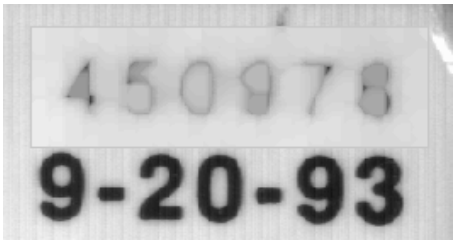


5. Return to the **Image Tool Edit** panel.
6. Set the number of Morph Passes to the number that completely filters out the characters in the window.

   Note: Increasing Morph Passes also increases the processing time.



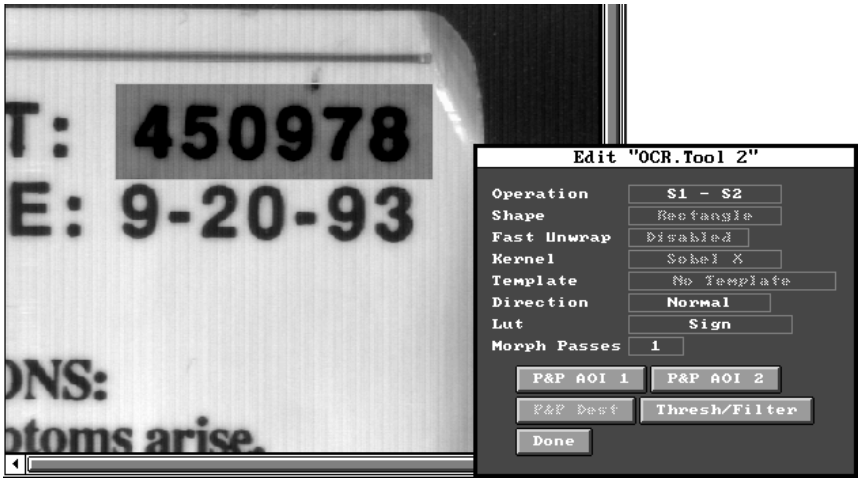
Morph Passes = 1



Morph Passes = 2

Morph Passes = 3

7. Setup Tool 2 as shown below:



8. Set the operation to S1-S2.
9. Use **P&P AOI 1** to position AOI 1 to the same position as tool 1 (use information obtained in step 3).
10. Use **P&P AOI 2** to position AOI 2 to:

    X = 0
    Y = 0
    Length = Tool 1 Length
    Height = Tool 1 Height

11. Set the lookup table to Sign by selecting LUT in the **Image Tool Edit** panel.
12. Tool 3 is an OCR Tool that uses the Tool 2 destination image. Setup the OCR Tool as described in this manual. The character recognition will be relatively insensitive to lighting variations.

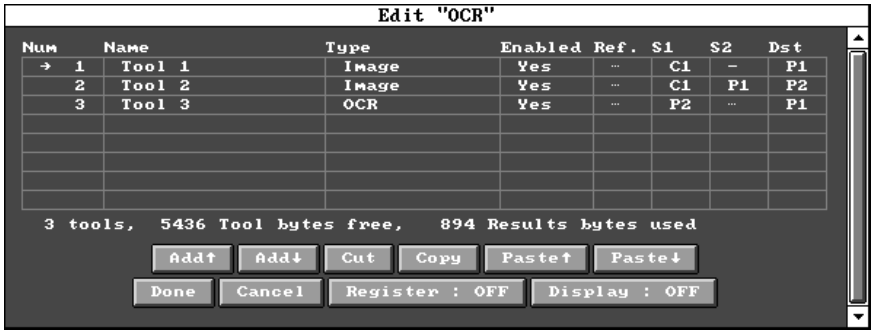
Method 2 – Brightness Compensation with Maximum Speed

Method 2 provides compensation for an overall increase or decrease in brightness with minimum impact to inspection speed. Method 2 can also compensate for uneven horizontal lighting across the character string, such as printing on round bottles. This method requires a window to be placed in an area of the image that will always be white. As in Method 1, Method 2 requires two Image Tools to preprocess the image for the OCR Tool.

- The first Image Tool produces a background reference image.
- The second Image Tool subtracts the background reference image from the original camera image to produce a compensated image for the OCR Tool.

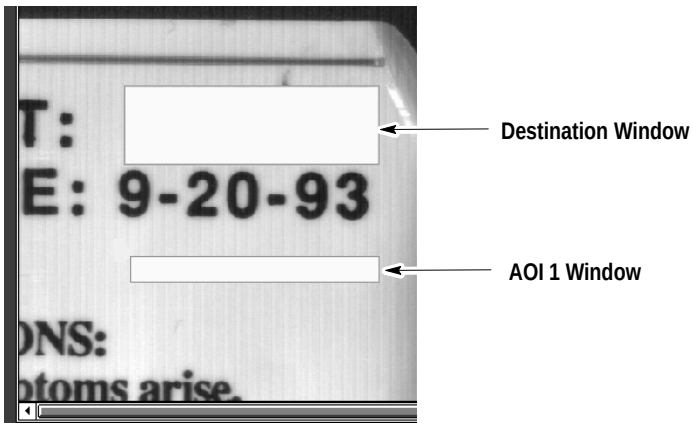
To setup Image Tools for brightness compensation with maximum speed:

1. Add tools to the toolset as shown below. Note the S1, S2, and Dst settings.


Edit "OCR"
Num Name Type Enabled Ref. S1 S2 Dst
→ 1 Tool 1 Image Yes … C1 – P1
2 Tool 2 Image Yes … C1 P1 P2
3 Tool 3 OCR Yes … P2 … P1
3 tools, 5436 Tool bytes free, 894 Results bytes used
Add↑ Add↓ Cut Copy Paste↑ Paste↓
Done Cancel Register : OFF Display : OFF

2. Use the **P&P AOI 1** to position the AOI 1 window in an area of the image that will always be white (as shown below). The size of AOI 1 is not important.
3. Set **Tool 1 Shape** to **Quad**.

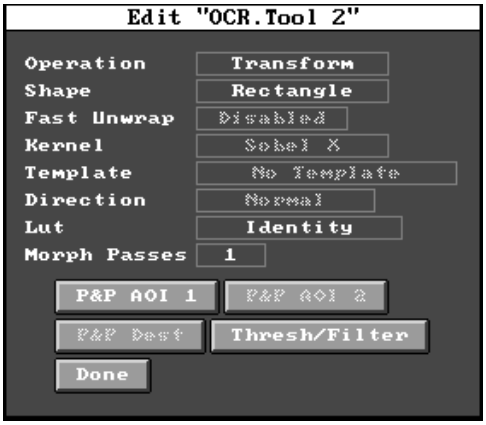
4. Use the **P&P Dest** to position the destination window over the character string(s) as shown below.



5. Record the X, Y, Length, and Height of the destination window for later use.

   X = _____
   Y = _____
   Length = _____
   Height = _____

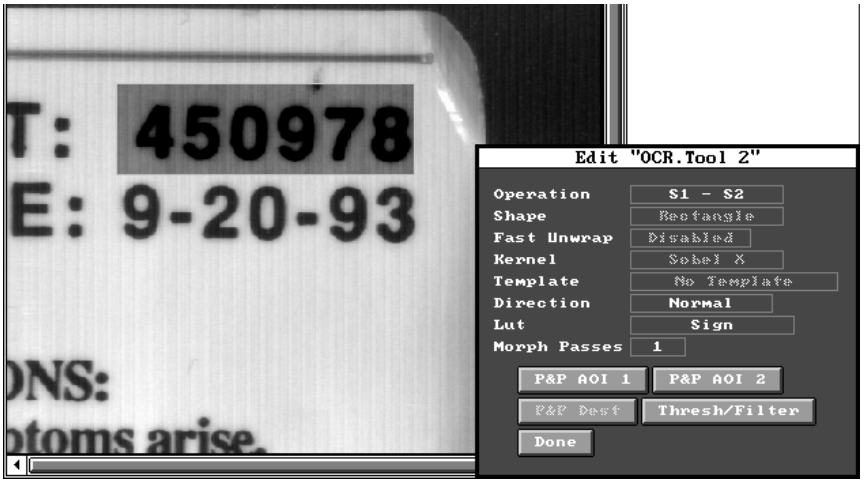
6. Display Tool 2, it should appear as shown below:



7. Set the operation to S1-S2.
8. Use **P&P AOI** 1 to position AOI 1 to the same position as the Tool 1 Destination (use information obtained in step 5).
9. Use **P&P AOI 2** to position AOI 2 to:

   X = 0
   Y = 0
   Length = Tool 1 Length
   Height = Tool 1 Height

10. Set the lookup table to Sign by selecting LUT in the **Image Tool Edit** panel as shown below:



11. Tool 3 is an OCR Tool that uses the Tool 2 destination image. Setup the OCR Tool as described in this manual. The character recognition will be relatively insensitive to lighting variations.

A

Acquired Image
An image received from the camera. In general, the same as *inspected image*.

B

Binary
Refers to an image whose pixels are either black or white.

Button
A button is an on screen interface feature that allows the operator to select or activate the item specified on the button. The button is activated by placing the cursor over the button and pressing the left mouse button.

C

Character
In general, a letter, number or symbol. In OCR, either a symbol which appears in the inspected image (*printed character*) or a pattern stored in an OCR font (*taught character*).

Character Pattern
A 32x32 matrix of pixels which describe the shape of a *taught character.* Each pixel may represent black (displayed in green during font teaching), white (displayed in yellow during font teaching), or *don't–care* (displayed as transparent during font teaching).

Character Recognition
Character recognition, in the image processing context, is the identification of individual *printed characters* by a machine vision method.

Confusion Character
A *printed character* which correlates with more than one *taught character.*

Correlation
This is the process by which characters are recognized. A printed character correlates if it is similar to a taught character pattern.

Correlation Box
A box which indicates the region over which a printed character correlates with a taught character.

Correlation Percentage
This is the percentage of pixels in the printed characters that must match the taught character in order for the character to be passed. The Correlation Percentage can be set individually for each character in an OCR font, and the default is 95%.

D

Default
Default refers to the original, or preset, parameter values that are used by the system unless otherwise altered by the operator.

Don't–Care
A pixel within a *taught character pattern* for which the corresponding pixel of a *printed character* does not affect the *correlation percentage*.

Download
The process of sending a file from a remote device to the CVIM2 module.

F

Filtering
A method of enhancing an image, which can be used to remove noise or improve the readability of characters.

Font
In typography, a particular style of characters. In OCR, a collection of taught character patterns and associated parameters (also called **OCR font)**.

Font File
A file on a CVIM2 module memory device in which a font is stored.

Font Name
The name of the font file used by an OCR Tool.

G

Grayscale
Refers to an image whose pixels can represent various shades of gray. In the CVIM2 these pixels have values from 0 (dark) to 255 (light).

M

Match String
A sequence of characters, entered by the user, against which a string read by the OCR Tool is compared.

O

Optical Character Recognition (OCR)
The process of optically reading printed characters, without testing the characters against a *match string*. This is used when the goal is to determine what printed characters are present.

OCR Font
See *font*.

Optical Character Verification (OCV)
The process of optically reading printed characters and testing the characters against a *match string*. This is used when the goal is to determine whether the printed characters match an expected pattern.

P

Pick & Place
The method of manually positioning a shape, such as a *processing window*, on an image. This operation consists of *picking* part of the shape with the mouse, *dragging* it to a new location, and *placing* it there.

Processing Window
The window used to define the region of the image which will be processed by the OCR Tool.

Pixel
A pixel is a *picture element*. This term can be used to refer to one element of an *image*, a dot on the CVIM2 module display screen, or one element of a *character pattern*.

Printed Character
A character which appears in an *acquired image*.

S

String
In general, a sequence of characters. In OCR, this can refer to one line of text read by an OCR Tool, a line of *printed characters*,

String Length (Len)
This is the maximum number of characters which will be read by one string of an OCR Tool if the *Subset* option is set to Left or Right.

Subset
A means of truncating the string of read characters. The string can be truncated from either the left or the right.

T

Taught Character
One element of an *OCR font*, consisting of a *character pattern*, a set of *filtering* parameters, and a *correlation percentage*.

Thin
An operation which erodes and reduces the *pixels* of the image of a *printed character*, for the purpose of teaching a *character pattern*.

Threshold
The process by which a *grayscale* image is converted into a *binary* image. Also refers to the limit(s) which define the separation between black and white. In the CVIM2 module, pixels in the grayscale image whose values are less than the *high threhsold* and greater than the *low threshold* will become white, and the rest will become black.

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